Value of Time for Bus Passengers

FINAL Report

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Background

Currently, changes in bus passenger waiting time (at the bus stop) are valued at 2.5 times the value of in-vehicle journey time changes. This factor is used in business cases for service changes.

It is thought that recent technological changes allowing for many bus passengers to access 'live' waiting time (through Countdown, Smartphone or tablet apps, the internet and SMS) when waiting for buses or even before arrival at the stop may reduce the negative impact of waiting time. In addition, the availability of such information may lead to behavioural change, for example, delay leaving home or work (this reducing the time waiting at the stop), walking to the next stop, doing something else like shopping, changing route or mode.

Therefore, research was undertaken to assess whether there is a case for adjusting the wait time multiplier and, if so, to what.

Objectives

There were six key research objectives:

- To understand the impact of live bus arrivals information on passenger's perception of (waiting) time
- To establish the multiplier of bus passenger waiting time 'at stop' vs 'on the bus'
- To establish passengers perceptions' of waiting time through the different channels
- The likelihood to which passengers might change their behaviour as a result of knowing the bus arrival times in advance
- To understand if the value of real time information differs eg in different circumstances
- What factors influence their expectations of average/usual wait time and overall journey time.

Methodology

A mixed mode survey approach was used:

- At bus stop recruitment of bus users at 21 stops with a follow up online or telephone survey. 1,397 recruitment interviews were undertaken and 318 online and 97 CATI completed interviews were achieved (415 in total).

- Online interviews with a sample of bus users supplied by TfL from their Oyster user database: 1,006 completes were achieved.

Waiting time multipliers

The sample was weighted using the London Bus User Survey to reflect the composition of the bus user population in London.

KEY FINDINGS

Overall, current London bus travellers value changes in their waiting time at the bus stop 2 times more than changes in their in-vehicle time. This overall multiplier is smaller than the currently recommended value by DfT (WebTAG of 2.5 for commuting and other purposes). However, it is up to date, London-specific, and takes account of the emerging impacts of live traveller information which can be observed to act to lower the average values. We therefore suggest that a multiplier of 2 is used for current appraisals.

The use of live bus information has a significant impact on the multiplier:

	Sample %	multiplier
Haven't checked or no access to information	61	2.2
Checked waiting time using Mobile	32	1.7
Checked waiting time using Internet	4	1.0
Checked waiting time using both Mobile and Internet	2	0.8
Overall	**100**	**2.0**

Using the monetary value of travel time saving obtained from the UK national Value of Travel Time (2015) study, we calculated the monetary value of the waiting time by different journey purposes in this study, as shown below:

	Commute	Others
Value of Travel Time study (2015) (£/hr)	11.21	5.12
Multiplier of waiting time from this study (after weighting)	1.83	2.37
Monetary value of waiting time (using VoTT 2015) (£/hr)	20.50	12.11

The values vary by different journey purposes and journey length.

- Commuters and those on personal business had a higher value of in-vehicle travel time than leisure travellers. The ratio of the in-vehicle time coefficient for 'commuting' relative to 'leisure' is 1.3 which is a little higher than the value of 1.1 provided in DfT WebTAG.

- Passengers on longer journeys had a higher value of in-vehicle travel time savings than those making shorter journeys.

After controlling for socio-demographic factors and journey characteristics, live bus information has a significant impact on bus users' value of expecting waiting time.

- By checking live bus information before their journey, passengers spent less time waiting:
  On <u>low frequency</u> routes:
  - no information: 6.7 minutes expected waiting time
  - information but not checked: 8.4 minutes expected waiting time
  - checked information 4.5 minutes expected waiting time

On high frequency routes:

- no information: 5.9 minutes expected waiting time
- information but not checked: 5.4 minutes expected waiting time
- checked information 4.3 minutes expected waiting time

- It is noticeable that for passengers who have checked their bus information before their trip, there is no significant difference in the expected waiting time between the passengers on the high and low frequency routes. This implies that using the live bus information helps passengers manage their expected waiting time.

Bus users who checked live bus information prior to making their journey were less sensitive to changes in the expected waiting time and more sensitive to changes in their in-vehicle time. They therefore had a lower multiplier.

- The multiplier for people who checked using Internet is lower than those who used a smartphone/tablet app. Participants who used both approaches were found to have the lowest multiplier.

- This implies for a well pre-planned bus journey, passengers valued their waiting time the same or even less than their journey in-vehicle time. This is to be anticipated as these users will feel that they have good control over their waiting time, and possibly more so than their control over the in-vehicle time once they have boarded.

Use of live bus arrival time information

61% of bus users got live bus arrival information: 52% via a Smartphone or Tablet app, 11% used an Internet site and a further 2% SMS. 4% used more than one means. However, 39% did not use any live information.

Those who did **not** use these means of live bus arrivals information were more likely to use a bus stop with Countdown than those who did use these means of live bus arrivals information: 47% compared to 34%.

Those who did **not** use these means of live bus arrivals information were older (65% aged over 50 compared 24% aged 30-49 and 29% aged under 30) and less likely to be employed (49% not employed, 36% employed).

How planned arrival time at bus stop

84% of those who did **not** use any means of live bus arrivals information just turned up at the bus stop, 31% because they knew the bus was frequent. 12% said they knew when the bus was due to arrive.

When and where checked live bus arrival information

Two thirds of those who used live bus arrival information did so **before** arriving at the bus stop.

- 53% checked live bus arrival information at home

- 46% on street
- 17% at workplace
- 14% or on a train, tram or another bus.

Behavioural impact of live bus arrival information

56% of those who checked live bus arrival information prior to arriving at the bus stop, changed their behaviour based on that information.

- 39% leave later than they would have
- 14% used another bus route
- 13% went to a different bus stop

Activities at Stop and on Bus

The most common activity undertaken during the wait at stops and on bus was using a phone or smartphone:

	At stop	on bus
• using a phone or smartphone	40%	43%
• listening to music	18%	24%
• talking to travelling companions	12%	11%
• reading book/magazine/paper	6%	16%
• doing nothing	39%	15%.

Overall, bus users rated time spent on the bus more highly than time at the bus stop, in terms of both how enjoyable (mean scores on scale of 0 completely enjoyable to 10 very enjoyable) and productive (mean scores on scale of 0 completely unproductive to 10 very productive) that time was:

	Enjoyable	Productive
• At stop	3.7	2.9
• On bus	5.1	4.3

Policy implications and recommendations

The study results have several implications on both policy makers and service design.

First, live bus information has the ability to improve bus users' experience by providing information to them before they reach the bus stop and changing how long they have to wait, particularly for those travelling on low service frequency routes. When evaluating the benefit of live bus information, impacts on waiting time saving along with the other benefits should be considered.

Second, this survey shows that the London-specific waiting time multiplier is lower than the current DfT WebTAG recommended value. In addition, live bus information acts to reduce the multiplier and therefore over time as the use of this technology increases we would expect the average multiplier to be reduced further. When appraising future London bus schemes it will be important to take into account the lower penalties now being placed by some groups on bus waiting times.

Based on the findings above, we recommend using a bus wait time multiplier of **2.0** in the current appraisal of schemes. This multiplier is the weighted value using the sample composition from the TfL bus user survey (2014) to better reflect the bus user population profile (weighted by age, gender & journey purpose).

Moving forwards, it will be possible to adjust the overall multiplier by changing the proportions of bus users assumed to be checking the waiting times in advance of leaving for their bus stop. This will allow short term adjustments to be made, but periodically this study should be repeated to provide updated estimates of the waiting time multipliers for each group as these could continue to change in response to other societal changes and the changing expectations of service users.

1. INTRODUCTION

1.1 Background

The key driver for bus user satisfaction is reliability which is comprised of journey time and the time waited to catch the bus. The latter is very much influenced by passenger perceptions of waiting times.

Currently, bus passenger waiting time (at stop) is valued at 2.5 times the value of in-vehicle journey time. This factor is used in business cases for service changes.

It was thought that recent technological changes allowing for many bus passengers to access 'live' waiting time (through Countdown, Smartphone or tablet apps, the internet and SMS) when waiting for buses or even before arrival at the stop may reduce the negative impact of waiting time. In addition, the availability of such information may lead to behavioural change, for example, delay leaving home or work (this reducing the time waiting at the stop), walking to the next stop, doing something else like shopping, changing route or mode.

Therefore, research was commissioned to assess whether there is a case for adjusting the wait time multiplier and, if so, to what.

Although Countdown has been available at bus stops since 1992, the real explosion in waiting time information has been much more recent with the boom in Smartphone use with associated travel apps.

Data included in the brief indicates that 54% of daily bus passenger journeys now use live bus arrival information:

- Countdown sign 37%
- App (phone/tablet) 24%
- Web 2%
- SMS 0.3%
- No live bus arrivals information 46%

Note: Some use more than one source

1.2 Objectives

Transport for London wished to understand the impact of live bus arrival information on perceived waiting times to ensure the continued accuracy of the multiplier and the process itself.

There were six key research objectives as stated in the brief:

- To understand the impact of live bus arrivals information on passenger's perception of (waiting) time, eg how does the customer's VoT for wait time compare with when they don't use live bus arrivals?

- To establish the multiplier of bus passenger waiting time 'at stop' vs 'on the bus'

- To establish passengers perceptions' of waiting time through the different channels (ie countdown, app etc)

- The likelihood to which passengers might change their behaviour as a result of knowing the bus arrival times in advance (ie before arriving at the stop) through SMS or the TfL website (this could include mode shifting)

- To understand if the value of real time information differs eg in different circumstances such as by journey purpose, if it is time critical, time of day, familiarity with journey and if the weather is good/bad

- What factors influence their expectations of average/usual wait time and overall journey time? eg can we gather insight on how they currently use their time on bus eg reading, email, Facebook, looking out of window etc

2. METHODOLOGY

2.1 Introduction

The research method incorporated stated preference and this was used to answer the first three objectives:

- To understand the impact of live bus arrivals information on passenger's perception of (waiting) time
- To establish the multiplier of bus passenger waiting time 'at stop' vs 'on the bus'
- To establish passengers perceptions' of waiting time through the different channels (ie countdown, app etc)

The remaining objectives were answered through non stated preference questioning.

2.2 Method

A mixed mode survey approach was used:

- At bus stop recruited bus users (with a follow up online or telephone survey)

- Online interviews with a sample of bus users supplied by TfL from their Oyster Database.

Details of each approach are shown below.

At bus stop recruitment

The intercept CAPI survey was administered face-to-face using Android tablets at 21 bus stops across the capital. Bus users were approached using a random 1 in n approach at bus stops. A few scoping questions were asked to ensure that the sample quotas were met:

- Main journey purpose (minimum 40% commuting)
- Access mode to stop (minimum 50% walk)
- Age: (minimum 20% under 29, 25% 30-49 min, 15% 50+)
- Gender: (minimum 40% male).

If in scope, participants were invited to undertake a follow-up survey on-line or by phone (and relevant contact details were collected). Those providing e-mail addresses were automatically sent an e-mail with a unique web-link to the survey at the end of each shift. The names and phone numbers of those preferring to undertake the interview by phone were loaded into the telephone unit sample on a daily basis.

A £5 'than you' was offered to encourage response.

The fieldwork took place between 12 and 29 March 2016.

Overall, 1,397 recruitment interviews were undertaken (target = 1,400) with 1,156 emails and 241 phone recruits. Quotas were broadly met.

There were 318 online completes. The average online questionnaire completion length was 13 minutes. CATI interviews took place from 17 March to 3 April. There were 241 numbers uploaded to the telephone unit and 97 interviews undertaken. The average interview length by phone was 17 minutes.

Oystercard Sampling Method

TfL sampled their database of Oystercard holders by selecting those who had used bus at least twice in the preceding eight weeks.

Potential participants were sent emails with a link to an online survey.

The online survey included scoping questions to ensure that the participants had made a recent bus trip within last two weeks.

A sample of at least 1,000 completes were aimed for and 1,006 completes were achieved. 693 entered the survey but did not complete, with 221 just opening the landing page and not proceeding further. The average questionnaire completion length was 13 minutes.

Further details of the method are included in Appendix C.

A Word version of the computer questionnaire used for the recruitment, online and telephone surveys is included in Appendix B.

2.3 Stated Preference experiment design

Selection of attributes

To fulfil the research objectives, a stated preference experiment was embedded in the questionnaire.

Two different approaches were considered for examining how the value of waiting time varied according to the live bus information sources available:

1. A choice experiment including information source as an attribute
2. A choice experiment without information source as an attribute, but with information usage collected in the background questions which could then be used to determine whether the value of waiting time varied between those exposed to different information sources.

We took the decision to adopt the second approach, in which the same stated preference (SP) experiment design is used for the entire sample but segmentation is incorporated in the analysis to account for differences in live bus information provision.

We had considered the first option of including the type of information provision (none, countdown, mobile app) explicitly as an attribute in the SP choice experiment but concluded that this had a number of disadvantages. Most importantly, it requires asking participants to imagine a world where they have more or less information than they have at present, but provides them with an accuracy of waiting time estimates that they may or may not perceive in the real world. Whilst including the information provision as an attribute within the task would be theoretically feasible, it will always be better to survey people that are familiar with the actual circumstances that you want to value, should they exist, and draw upon their own experiences and perceptions in the valuation.

We also took the decision to utilise recently published values of time from the recently published UK Value of Travel Time report[1] and focus this new research on quantifying the relative value of bus waiting time and in-vehicle time under the different levels of information provision. This has allowed us to utilise the precision in the monetary estimates that were gained through the large sample sizes used in the national study.

The additional advantage of focusing this study on the relative value of bus waiting time and in-vehicle time is that this avoids the complications that would otherwise present themselves in framing a monetary valuation task for those on free or discounted tickets. This aspect was explicitly taken into account within the UK national study, so we know that the values of time are appropriate for these groups. We have therefore been able to concentrate on examining whether the valuation of waiting time differs according to use of discount or concessionary fares, and not having to build in the additional complication of developing an appropriate (but different) monetary vehicle for these participants. This has also allowed a consistent approach across all bus users, which is desirable in eliminating any possible biases that might otherwise confound differences between sub-groups and differences in task.

The result of these decisions is that we developed a relatively simple, yet focused, stated preference choice experiment but with larger sample sizes than might have otherwise been advocated due to the decision to value the differences resulting from information provision through segmentation of the sample. The choice experiment is therefore a choice between two journeys with differences in the expected waiting and the in-vehicle times and an option of "not travel by bus".

Stated preference experiment design

Participants were asked about the journey characteristics of their most recent journey or the journey they made when they were interviewed at the bus stop. The levels of SP attributes were tailored to each participant's stated expected waiting and journey time to increase the realism of the choice experiment.

Each participant was presented with 8 hypothetical scenarios. Each choice scenario consisted of two alternatives (bus journey A and B) and an option "I would not travel by bus" which allowed participants to indicate that neither

[1] https://www.gov.uk/government/publications/values-of-travel-time-savings-and-reliability-final-reports

option would be acceptable to them. The details of the experiment design can be found in Appendix H and an example of a choice is presented below in Figure 1.

Figure 1: Example choice scenario

Please imagine that you are making the same journey again, under the same circumstances.

We would now like you to consider a series of situations where you have a choice between two different bus options for that journey but that the expected waiting time for the bus and the travel time on the bus may differ.

Please imagine that these are the options and information available to you and indicate which of the bus options you would chose for this journey, or whether you would decide not to use either bus under the conditions presented.

	Journey A	Journey B	I would not travel by bus
Expected Waiting Time	3 mins	5 mins	
Expected Journey Time	15 mins	13.5 mins	
Choice	○	○	○

In addition to the choice experiment, the survey was designed to collect participants' recent experience of their bus journey, their access to and use of live bus information, their use of time at the bus stop and during the bus journey, as well as their socio-demographic information.

The SP choice design and format was tested through a pilot survey. This showed that the SP experiment worked as intended and so the design was not amended for the main survey.

As no change was made to the SP design after the pilot survey, the pilot data has been pooled with the main survey data to analysis. As a result, the analysis included data from 1690 participants (269 from pilot survey and 1421 from the main survey).

2.4 Pilot

The method and questionnaire was piloted

A report on the pilot and on the pilot SP analysis is included in Appendix D.

2.5 Weighting

The data was weighted to match the 2014 Bus User Survey with respect to age, gender and journey purpose. Details on the weighting procedures are included as Appendix E.

3. FINDINGS

3.1 Introduction

This chapter sets out the key findings of the research under the following headings:

- Wait Times
- Analysis of the stated preference choices
- Use of Live Bus Arrival Time Information
- Activities at Stop and on Bus
- Bus Trip Characteristics
- Participant Demographics.

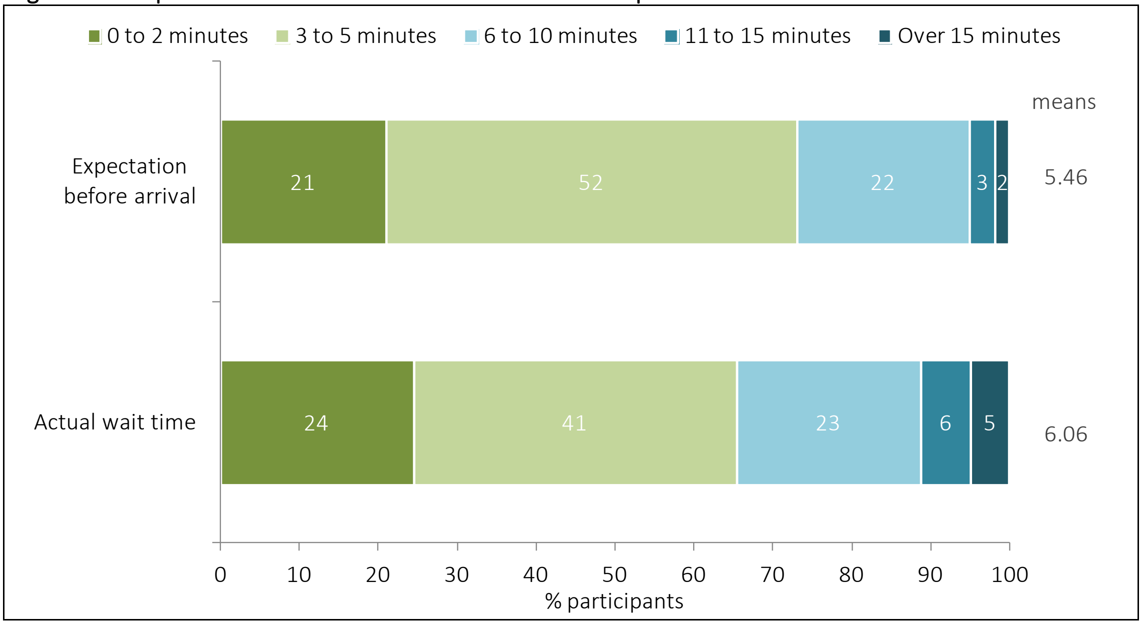
Appendix A, G and H provides further details on the research findings.

3.2 Wait Times

Live bus information provides bus users arrival information before they reach the bus stop. In the survey, undertaken after the trip, participants were asked to recall what they had expected their waiting time to be before arriving at the bus stop. We examined if this information impacted passengers' expected waiting time by comparing the average expected waiting time by different means of checking live bus information.

All participants were asked to give an indication of how long they expected to wait for the bus at the stop before they got there and then, the actual wait time. The expected wait time (mean wait of 5.46 minutes) was slightly shorter than the actual wait time (6.06 minutes). See Figure 2.

Figure 2: Expected and actual wait time at bus stop



Weighted base: All participants (1,421)

Bus users who did **not** use live bus arrival time information had longer expected wait times than those did: 6 minutes on average compared to 5.1 minutes.

Those who checked live bus arrival time information before getting to the bus stop had both shorter expected and actual wait times than those who did not:

	Expected	Actual
• Checked live info before getting to bus stop	4.5	5.8
• Did not check live info before getting to bus stop	6.3	7.0

A matrix of expected and actual wait times (by time ranges) shows that slightly over half (53%) actually waited about as long as they expected to wait, 27% waited longer and 20% waited shorter than expected.

Table 1: Matrix of expected v actual wait times

	Actual wait time					
Expected wait time	0 to 2 minutes	3 to 5 minutes	6 to 10 minutes	11 to 15 minutes	Over 15 minutes	base
0 to 2 minutes	12	6	2	0	0	299
3 to 5 minutes	10	29	10	2	1	740
6 to 10 minutes	2	5	10	3	2	310
11 to 15 minutes	0	1	1	1	1	47
Over 15 minutes	0	0	0	0	1	25
Base	348	582	331	90	70	

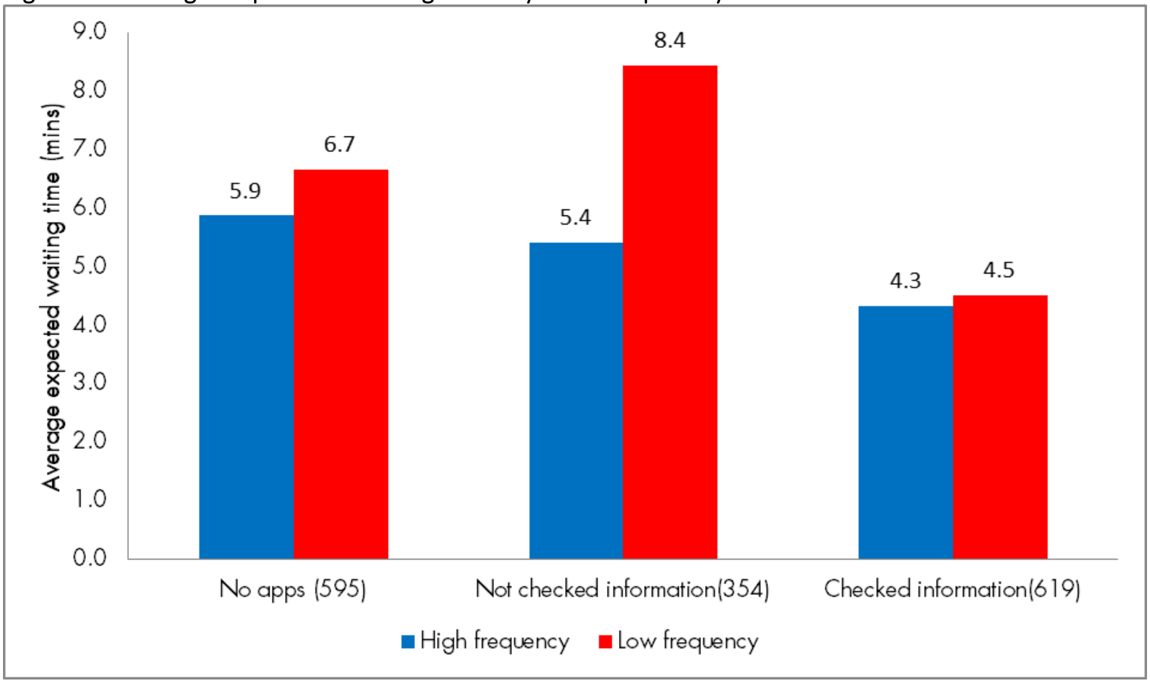
Analysis by frequency of service

Bus users on low frequency[2] routes have a slightly longer expected waiting time compared to those on the high frequency routes, as would be expected without taking account of information provision. However, this difference varies across the different information provision groups.

For passengers who have no access to the live information, their expected waiting times are 5.9 and 6.7 minutes per trip, for high frequency and low frequency services, respectively. For those who have access to the live bus information, pre-planning their trip (by checking live bus information) was observed to help participants to reduce their expected waiting time, especially for those travelling on the low frequency routes (the difference from those without information is 2.2 minutes per trip and from those with information but who haven't checked is 3.9 minutes/trip (the impact is statistically significant)).

[2] The bus frequency information was retrieved from the operational details of bus routes in London using participants stated bus number and time travelled. The high frequency service is defined as 5 services per hour or more (i.e. headway is 12 minutes or less). More details can be found in Appendix G

Figure 3 Average expected waiting time by bus frequency and access to live information



Interestingly we found that for low frequency services, the average expected waiting time for passengers without information (6.7 minutes) is shorter than that of the passengers who have information but did not check prior to their journey (8.4 minutes), although the impact is only significant at 90% confidence interval.

It is noticeable that for participants who have checked the bus information before the bus trip, their expected waiting time is less compared to the first two groups and the difference in the waiting time between the high and low frequency routes is very small at 0.2 minutes per trip. This implies that checking live bus information helps bus users to reduce their expected waiting time, particularly for low frequency services. This finding is consistent with previous empirical evidence[3].

3.3 Analysis of the stated preference choices

Prior to developing the discrete choice models, we have examined the responses to a set of diagnostic questions that formed part of the questionnaire to explore participants' understanding of the choice experiment and their perception of the realism of the choices. This showed very high levels of understanding and ease of task. See Appendix H for more details.

[3] Watkins et al. (2011) have also found that real-time bus information reduces actual wait times. Furthermore, Ferris et al. (2010) have found that by reducing the "frustration and uncertainty of not knowing when a bus is really going to arrive," also reduces perceived wait times (Ferris et al. 2010, p. 1811).

Development of the discrete choice models

Discrete choice models have been developed using data from the choices that participants made in the experiments (see Appendix H for the theoretical background on discrete choice modelling and the detailed model results).

The estimation procedure assumes that participants chose the alternatives that provide them with the highest utility (the highest overall value to themselves). The outputs from the estimation procedure are attribute coefficients that reflect the weight that participants place on the expected waiting and bus in-vehicle journey time attributes, and best represent the (stated) choices made by the participants.

The ratio of the model coefficients quantifies the marginal rate of substitution between attributes, or in other words the multiplier of disutility per minute for expected waiting time in relation to the bus in-vehicle time.

In developing the model, we have removed the small number of night bus journeys[4] from the sample that occurred between 0:00 – 4:59am (n=49), and have also removed the small number of trips made for employer's business (n=45) [5], as well as the very small groups of participants who stated that they used SMS (n=9)[6].

A key part of the model analysis was to investigate how choices and preferences are influenced by the demographic characteristics of the participants and their journey characteristics. Table 2 presents the list of the factors that were examined in the development of the choice models. These were interacted with the bus in-vehicle time and expected waiting time terms.

Table 2: Factors examined in the development of choice models

Journey characteristics	Bus and arrival information	Demographic and other
Journey frequency	Bus frequency	Age
Journey purpose	Stop with Countdown	Gender
Ticket type	Means of checking arrival info.	Employment
Group size	Checked or not	Income
Journey length	Where did you checked	Weather condition
Time of day		

A subset of these factors was then selected from the separate tests to take forward into the main combined model (highlighted in the table above). The selection of the factors is based on considering the previous evidence and model outputs (details are presented in Appendix H).

To summarise the main findings:

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[4] This is suggested by TfL to allow better comparison with other TfL studies

[5] Participants who travelled for employer business purpose are removed from the data analysis. This is to have a like-for-like comparison with the DfT WebTAG waiting time – journey time multiplier where the EB is not included.

[6] Due to the very small sample for this group, the coefficient estimated for SMS distorted (very high) the value of waiting time. Therefore, we decided to remove it.

- Compared to participants who made journeys with a shorter **journey length** (less than 10 minutes in this study), those who made journeys with a longer length are found to value in-vehicle time more negatively (per minute).

- Compared to participants who are commuting, or travelling for personal business and education **journey purposes**, those who travelled for other leisure purposes are found to value in-vehicle journey time less negatively.

- We found that **live bus information**[7] impacts both on the participants' values of expected waiting time and in-vehicle time. The magnitude varies by different means of checking the information.

- We have also found some significant impact of **age** on the waiting time attribute. People who are aged between 17 and 20 are found to have less negative values for waiting time (per minute).

- **Bus frequency** has been found to have an impact on the participants' value of waiting time. We found that compared to participants who travelled on the high frequency routes and those for whom bus frequency information is not available, those who travelled on the low frequency routes have less negative valuations of waiting time.

Calculation of the waiting time multipliers

A sample enumeration approach[8] is adopted to calculate the average waiting time multiplier across different information provision segments and the population. This allows the impact of each of the factors in the model to be considered together in calculating the multiplier for each individual within the sample (both unweighted and weighted) and then averaged to provide population values. The sample was weighted using the London Bus User Survey to reflect the composition of the bus user population in London. Table 3 presents the multipliers that result for each means of checking information.

Table 3 Waiting time – Journey time multipliers by means of checking information

Sample average values	Sample %	before weighting	after weighting
Haven't checked or no access to information	61	2.3	2.2
Checked waiting time using Mobile	32	1.8	1.7
Checked waiting time using Internet	4	1.0	1.0
Checked waiting time using both Mobile and Internet	2	0.8	0.8
Overall	100	2.0	2.0

Overall, we find that on average current London bus travellers value changes in their waiting time at the bus stop 2 times more than changes in their in-vehicle time. This overall multiplier is smaller than the currently recommended value by

[7] In the separate model analysis, we found that countdown information had an impact on the time attributes. However, this impact became less significant after the bootstrap procedure (t=-1.3). Therefore it was removed from the final combined model. However, our focus is on the passengers' expected waiting time before arriving at the bus stop.

[8] Sample enumeration approach implies drawing a 'representative' sample from the population and to calculate the average multiplier of waiting time using this sample. More details of this approach can be found in the book by Ben-Akiva and Lerman (1985).

DfT (WebTAG of 2.5 for commuting and other purposes). However, it is up to date, London-specific, and takes account of the emerging impacts of live traveller information which can be observed to act to lower the average values. We therefore suggest that a multiplier of 2 is used for current appraisals.

Using the monetary value of travel time saving obtained from the UK national Value of Travel Time (2015) study, we then calculated the monetary value of the waiting time by different journey purposes in this study, as shown in Table 4.

Table 4 Calculation of monetary value of waiting time using the Value of travel time study (VOTT) (2015) values

All modes value of travel time saving (£/hr)	Commute	Others
Value of Travel Time study (2015) (£/hr)	11.21	5.12
Multiplier of waiting time from this study (after weighting)	1.83	2.37
Monetary value of waiting time (using VoTT 2015) (£/hr)	20.50	12.11

Discussion of the key findings

Below we summarise the key findings from the SP analysis, discuss key points for interpretation of the results, discuss limitations of the research and provide recommendations based on the findings.

First, the quality of the choice data appears to be high.
The responses to diagnostic questions included within the survey suggest that nearly all the participants have a good understanding and stated that it was easy or moderately easy to make the choices in the SP exercises. In addition, examination of the responses to the background questions and the outputs from the separate models suggested that participants treated the SP experiment seriously and answered the choice questions in a rational way. Moreover, the waiting time – in-vehicle time multiplier calculated from the choice models are generally in line with or in the same order of magnitude as DfT WebTAG guidance and other UK public transport value of time meta-analysis results (Wardman, 2014).

Sometimes, hypothetic bias can occur in SP experiments with the impact of overestimating values. However in this study, there is no monetary term or new policy / infrastructure included in the choice set which previous evidence suggests could cause such bias (Wardman 2001). Therefore we judge the likelihood of having hypothetic bias as relatively low in this study.

Second, we found participants' socio-demographic features and their current journey characteristics have an impact on their value of the waiting time and in-vehicle time.

More specifically, these values vary by different journey purposes and journey length. We found that passengers travelling for commuting, education and personal business purposes (labelled as "commuting") compared with the shopping, visiting friends and other leisure purposes (labelled as "other") were attached a higher value to in-vehicle travel time. The ratio of the in-vehicle time coefficient for "commuting" relative to "others" in this study is 1.3 which follows the pattern seen in other studies but is a little higher than the value of 1.1

provided in DfT WebTAG. With regard to journey length, passengers on longer journeys were attached a higher value to in-vehicle travel time savings than those making shorter journeys. This is in line with the other evidence (Wardman 2014). These all resulted in a lower ratio of waiting time to journey time (multiplier) for commuting and longer journeys.

In addition, age was found to have an impact on the valuation of waiting time. Participants aged between 17 and 20 were found to be less sensitive to changes in their waiting time, after controlling the journey characteristics factors and differences in accessing bus information. Passengers who travelled on the low frequency routes are found to be less sensitive to changes in their expected waiting time. We could not find any evidence relating to these trends from other studies for comparison.

Third, after controlling the influence of socio-demographic factors and journey characteristics, live bus information is found to have a significant impact on bus users' value of expecting waiting time. The impacts reflect in two aspects.

By checking live bus information before their journey, passengers were observed to spend less time waiting. On average, the reduction of expected waiting time is from a range of 6.7 (with no information) to 8.4 (with information but not checked) down to 4.5 minutes per trip for passengers who travelled on the low frequency routes, and the range of 5.9 to 5.4 down to 4.3 minutes per trip for those on the high frequency routes.

	High frequency	Low frequency
No apps	5.9	6.7
Not checked information	5.4	8.4
Checked information	4.3	4.5
Totals	**5.2**	**5.9**

Though there is a wider spread for the average expected waiting time for the low frequency services. It is noticeable that for passengers who have checked their bus information before their trip, there is no significant difference in the expected waiting time between the passengers on the high and low frequency routes. This implies that using the live bus information helps passengers manage their expected waiting time.

Second, the modelling outputs indicate that the ratio of waiting and journey time (multipliers) differ according to the means used of checking live bus information. Bus users that stated they had checked live bus information prior to making their journey both were less sensitive to changes in the expected waiting time and more sensitive to changes in their in-vehicle time. They therefore had a lower multiplier. We observed that the multiplier for people who checked using Internet is lower than those who used Mobile phone. Participants who used both approaches were found to have the lowest multiplier. We notice that the multiplier for participants who used Internet to access the live information is close to or small than 1. This implies for a well pre-planned bus journey, passengers valued their waiting time the same or even less than their journey in-vehicle time. This is to be anticipated as these users will feel that they have good control over their waiting time, and possibly more so than their control over the in-vehicle time once they have boarded.

		Multiplier
Journey length	Short (under 10 minutes) Medium and long (over 10 minutes)	2.53 2.02
Journey purpose	Commuting, Personal business Other	2.53 3.36
Means of checking arrival information	Not checked Mobile Internet Mobile & Internet	2.53 2.03 1.23 1.09
Age	21 - 70+ 17 - 20	2.53 1.65
Bus Frequency	High frequency Low frequency	2.53 1.98

Policy implications and recommendations

The study results have several implications on both policy makers and service design.

First, live bus information has the ability to improve bus users' experience by providing information to them before they reach the bus stop and changing how long they have to wait, particularly for those travelling on low service frequency routes. When evaluating the benefit of live bus information, impacts on waiting time saving along with the other benefits should be considered.

Second, this new survey shows that the London-specific waiting time multiplier is lower than the current DfT WebTAG recommended value. In addition, live bus information acts to reduce the multiplier and therefore over time as the use of this technology increases we would expect the average multiplier to be reduced further. When appraising future London bus schemes it will be important to take into account the lower penalties now being placed by some groups on bus waiting times.

Based on the findings above, we recommend using a bus wait time multiplier of 2.0 in the current appraisal of schemes. This multiplier is the weighted values using the sample composition from TfL bus user survey to better reflect the bus user population profile.

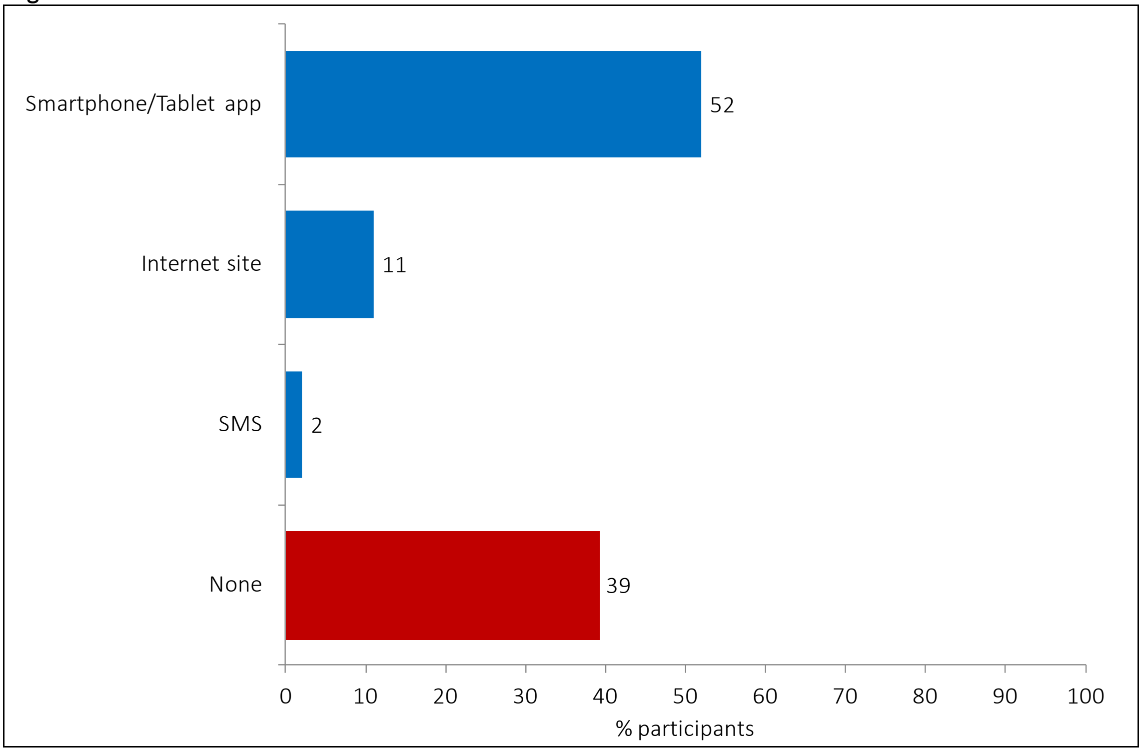
Moving forwards, it will be possible to adjust the overall multiplier by changing the proportions of bus users assumed to be checking the waiting times in advance of leaving for their bus stop. This will allow short term adjustments to be made, but periodically this study should be repeated to provide updated estimates of the waiting time multipliers for each group as these could continue to change in response to other societal changes and the changing expectations of service users.

3.4 Use of Live Bus Arrival Time Information

This section focuses on use of live bus arrival information and the extent to which passengers change their behaviour as a result of knowing the bus arrival times in advance.

Just over six tenths (61%) of bus users got live bus arrival information: 52% via a Smartphone or Tablet app, 11% used an Internet site and a further 2% SMS. 4% used more than one means. However, 39% did not use any live information. See Figure 4.

Figure 4: Whether used live bus arrival information



Weighted base: All participants (1,421)

Those who did **not** use these means of live bus arrivals information were more likely to use a bus stop with Countdown than those who did use these means of live bus arrivals information: 47% compared to 34%.

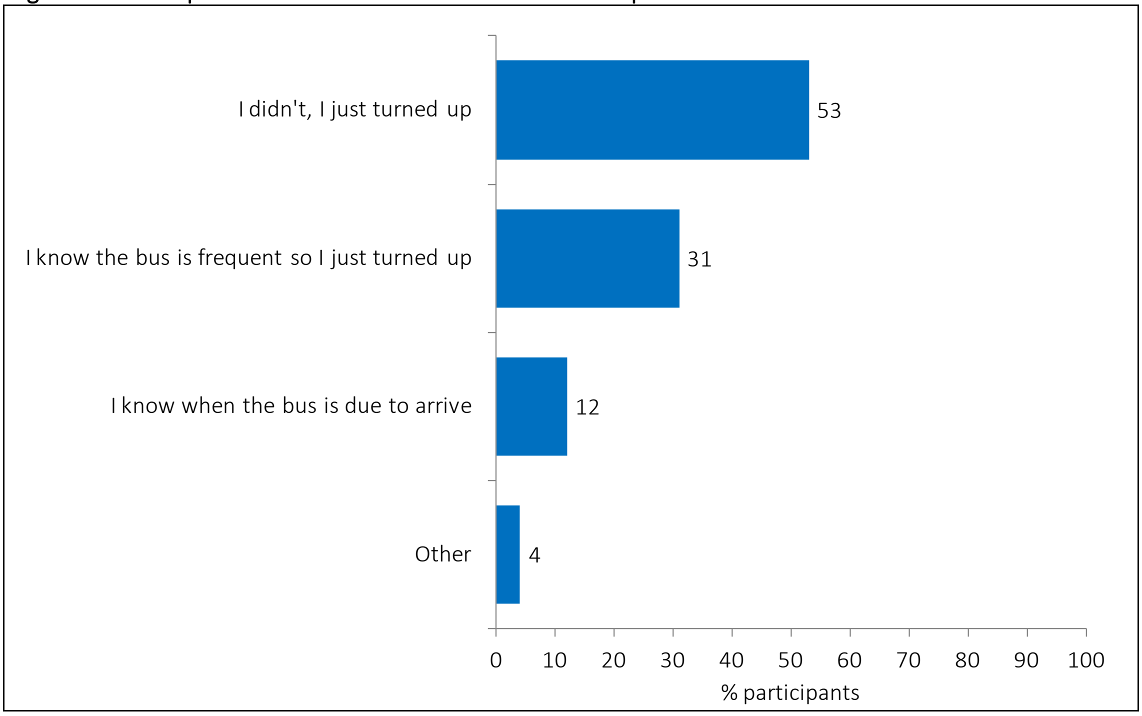
Those who did **not** use these means of live bus arrivals information were older (65% aged over 50 compared 24% aged 30-49 and 29% aged under 30) and less likely to be employed (49% not employed, 36% employed).

How planned arrival time at bus stop

Those who did **not** use these means of live bus arrivals information (39% of the sample) were asked how they planned their arrival time at the bus stop.

The majority (84%) just turned up at the bus stop, of which 31% said it was because they knew the bus was frequent (see Figure 5). Twelve percent knew when the bus was due to arrive.

Figure 5: How planned their arrival time to the stop



Weighted base: Those who did not use live bus arrival information (560)

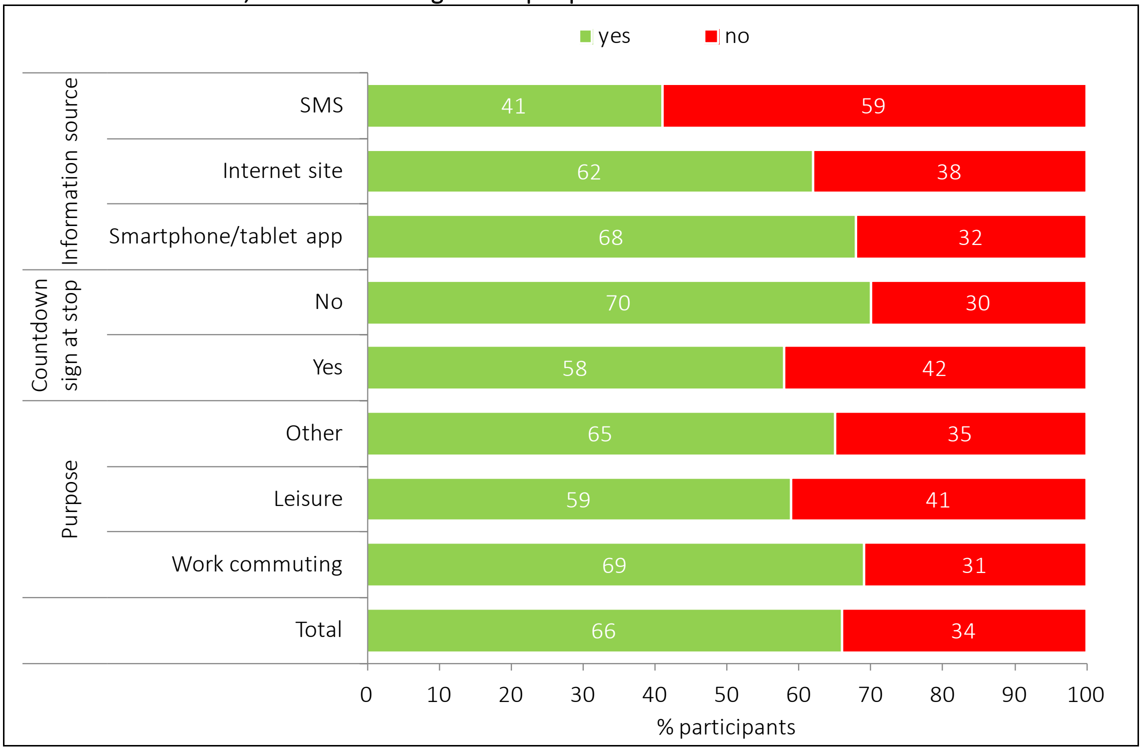
When checked live bus arrival information

Two thirds of those who used live bus arrival information did so before arriving at the bus stop:

- Users of smartphone or tablet apps were more likely than users of an internet site or SMS to do so (68% compared to 62% and 41% respectively).
- Work commuters were significantly more likely than leisure travellers to do so: 69% compared to 59%
- Users of bus stops with Countdown were significantly **less** likely to check live bus arrival information before getting to the stop: 58% compared to 70%

See Figure 6.

Figure 6: Whether checked the live bus arrival information before arrival at the stop by information source, countdown sign and purpose



Weighted base: Those who used live bus arrival information: Total 861; Purpose: Work commuting 479,
Leisure 238, Other 144; Countdown sign at stop: Yes 334, No 527; Information source: Smartphone/tablet app 736, Internet site 153, SMS 32

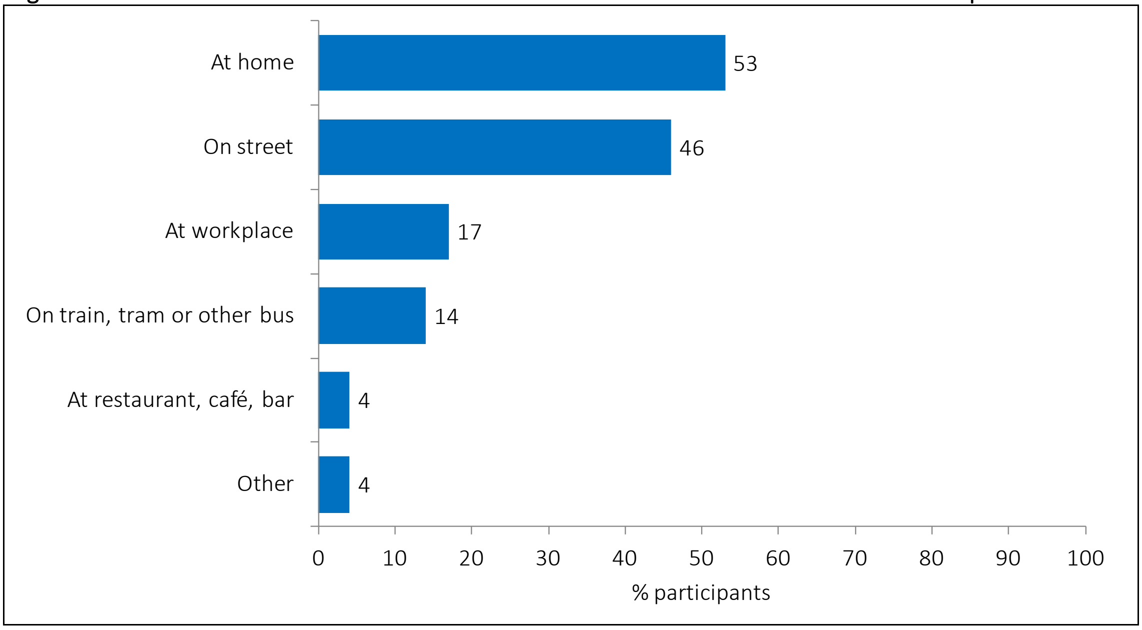
Where checked live bus arrival information

Two thirds of those who used live bus arrival information before they got to the bus stop were asked where they checked it.

Over half (53%) did so at home, 46% on street, 17% at workplace and 14% on a train, tram or another bus. See Figure 7.

Some checked at more than one location with an average of 1.4 locations per participant.

Figure 7: Where checked live bus arrival information before arrival at the stop



Weighted base: Those who checked live bus arrival information before arriving at the stop (565)

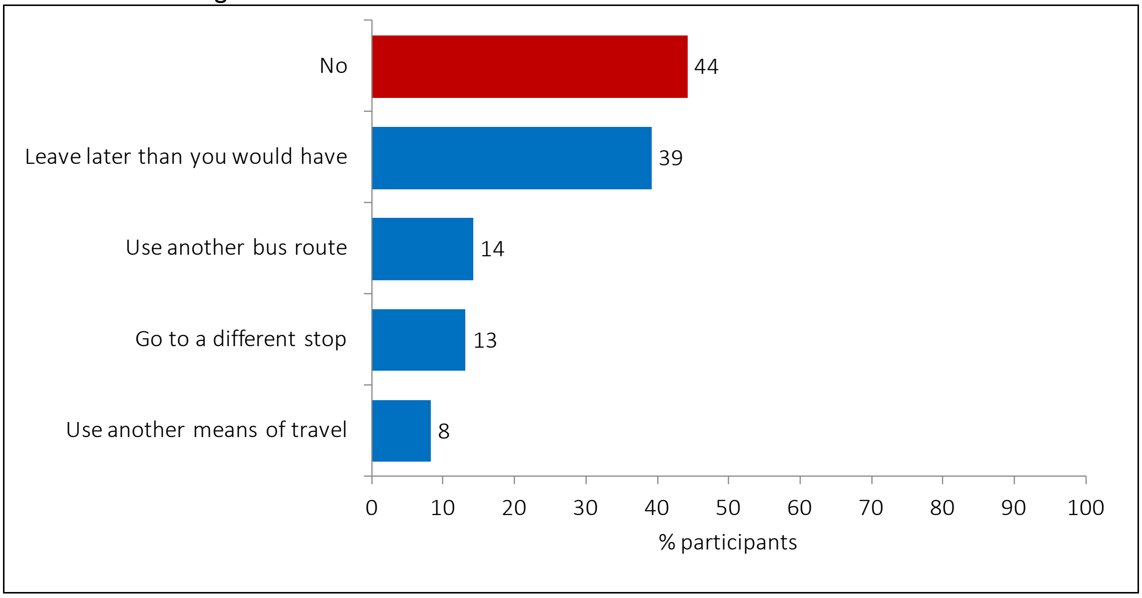
Behavioural impact of live bus arrival information

Over half (56%) of those who checked live bus arrival information prior to arriving at the bus stop, changed their behaviour based on that information.

Most commonly, this was deciding to leave later than they would have (39%), but some also chose to use another bus route (14%) or go to a different bus stop (13%). See Figure 8.

More than one behavioural change could be mentioned and on average 1.3 were mentioned.

Figure 8: Whether checking live bus arrival information before arriving at the bus stop led them to change behaviour



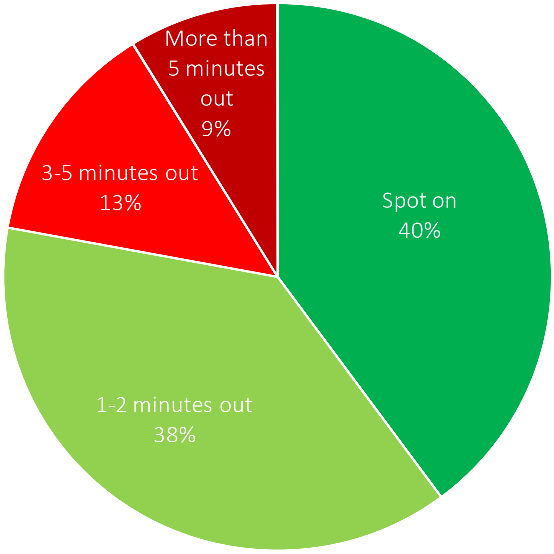
Weighted base: Those who checked live bus arrival information before arriving at the stop (565)

Those who received information from a smartphone or tablet app were less likely than those who used an internet site to change their behaviour: 56% compared to 65%.

Bus waiting time accuracy

The perceived accuracy of the live bus arrival information is high, with 40% of bus users saying that it was spot on and another 38% saying that it was 1-2 minutes out (see Figure 9). Just over a fifth (22%), however, thought that the information was three or more minutes out.

Figure 9: Accuracy of the live arrival information



Weighted base: Those who checked live bus arrival information before arriving at the stop (565)

Countdown

Less than half (44%) of bus users said that their bus stop had Countdown.

Nearly nine tenths (88%) at a stop with Countdown used it to check bus arrival time.

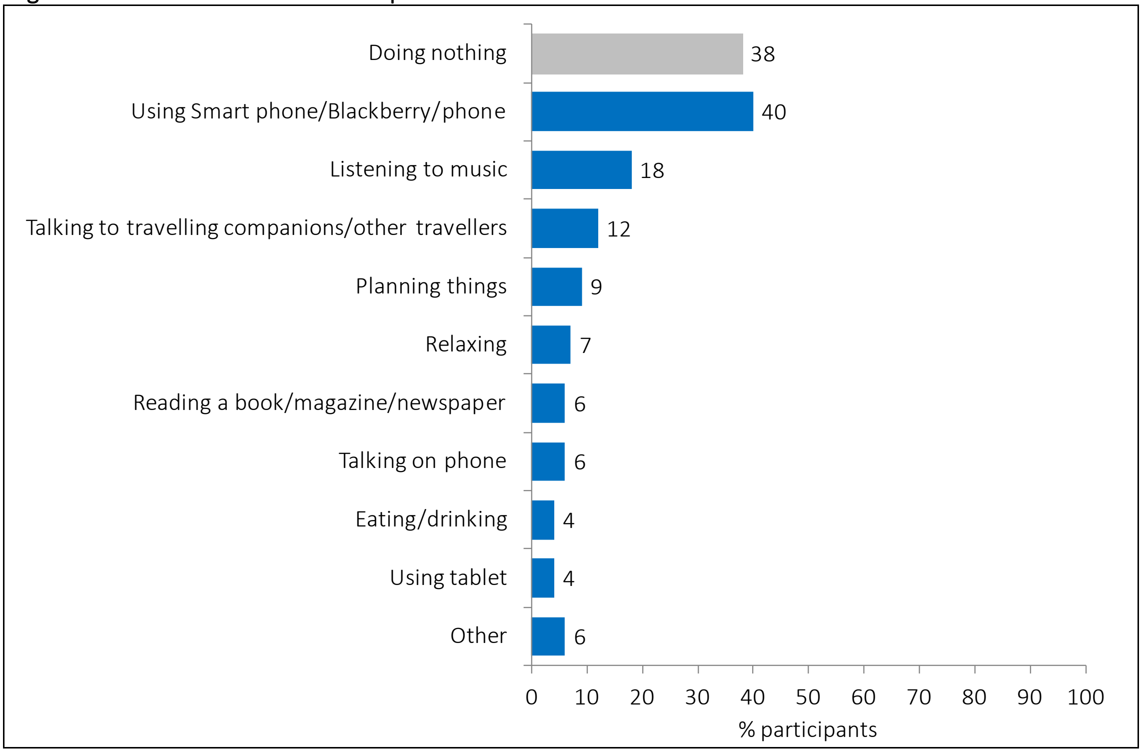
3.5 Activities at Stop and on Bus

This section explores the use of wait time at the bus stop and compares it to the use of time on the bus.

At the bus stop, the most common activity undertaken during the wait was using a phone or smartphone (40%). Eighteen percent listened to music and around an eighth (12%) talked to travelling companions or other travellers.

Just under four tenths (39%) said they did nothing. See Figure 10 for a detailed breakdown.

Figure 10: Activities at bus stop



Weighted base: Those who spent time waiting at bus stop (1,369)

The 62% who undertook activities at the bus stop undertook 1.8 activities each on average. There was a slight tendency to undertake more activities at the bus stop the longer the wait, although there was no significant increase for any one activity.

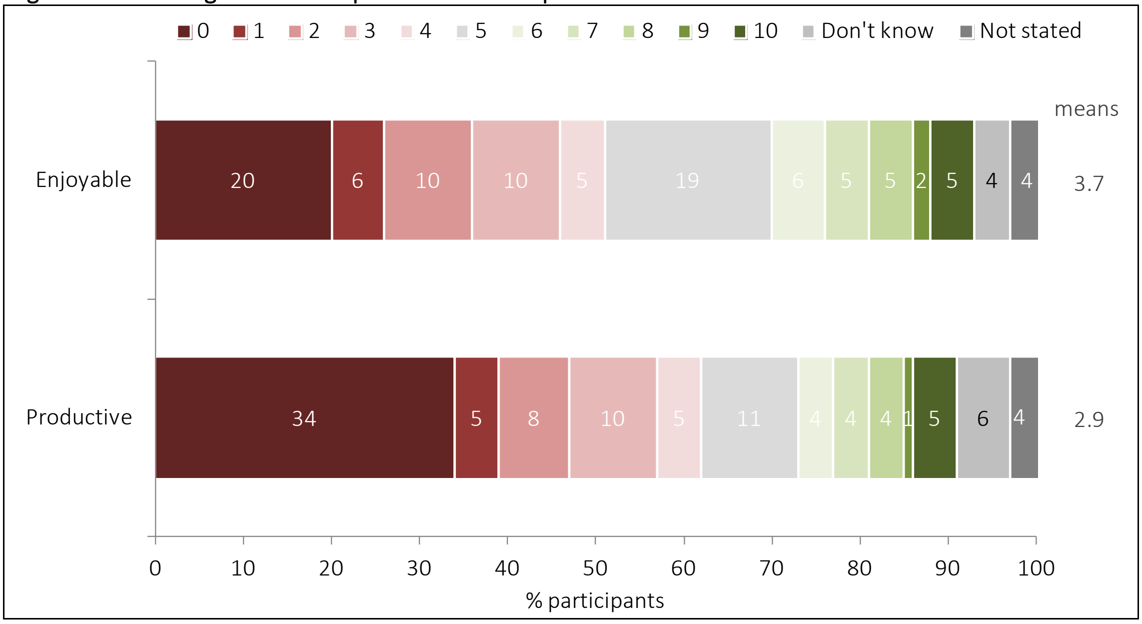
	activities
• 0 to 2 minutes	1.5
• 3 to 5 minutes	1.7
• 6 to 10 minutes	2.0
• 11 to 15 minutes	2.1
• Over 15 minutes	1.9

Enjoyment and productivity of wait time

Bus users were asked to rate the time spent waiting at the bus stop in terms of how enjoyable and productive it was on a scale of 0 to 10 (where 0 means 'completely unenjoyable'/'completely unproductive' and 10 means 'very enjoyable'/'very productive').

The overall ratings are low for both of the attributes, with the waiting time thought to be slightly more enjoyable (mean score 3.7) than productive (2.9).

Figure 11: Ratings of time spent at bus stop



Weighted base: All participants (1,421)

Those travelling for leisure or other purposes found the time waiting at the bus stop significantly more enjoyable and productive than those work commuting (mean scores below).

	Enjoyable	Productive
• Work commute	3.08	2.37
• Leisure	4.48	3.57
• Other purposes	4.21	3.35

There was a strong inverse correlation between the length of time waiting at the stop and whether it was enjoyable or productive. The longer the wait the less enjoyable and less productive the time was rated:

	Enjoyable	Productive
• 0-2 minutes	4.54	3.51
• 3-5 minutes	4.09	3.27
• 6-10 minutes	3.23	2.38
• 11-15 minutes	2.27	2.07
• Over 15 minutes	1.40	1.19

Those who were waiting at a bus stop with Countdown found the time significantly more enjoyable and productive than those at non Countdown stops which implies that knowing when the bus arrives heightens the enjoyment and productivity of waiting:

	Enjoyable	Productive
• Countdown	4.01	3.33
• No Countdown	3.47	2.57

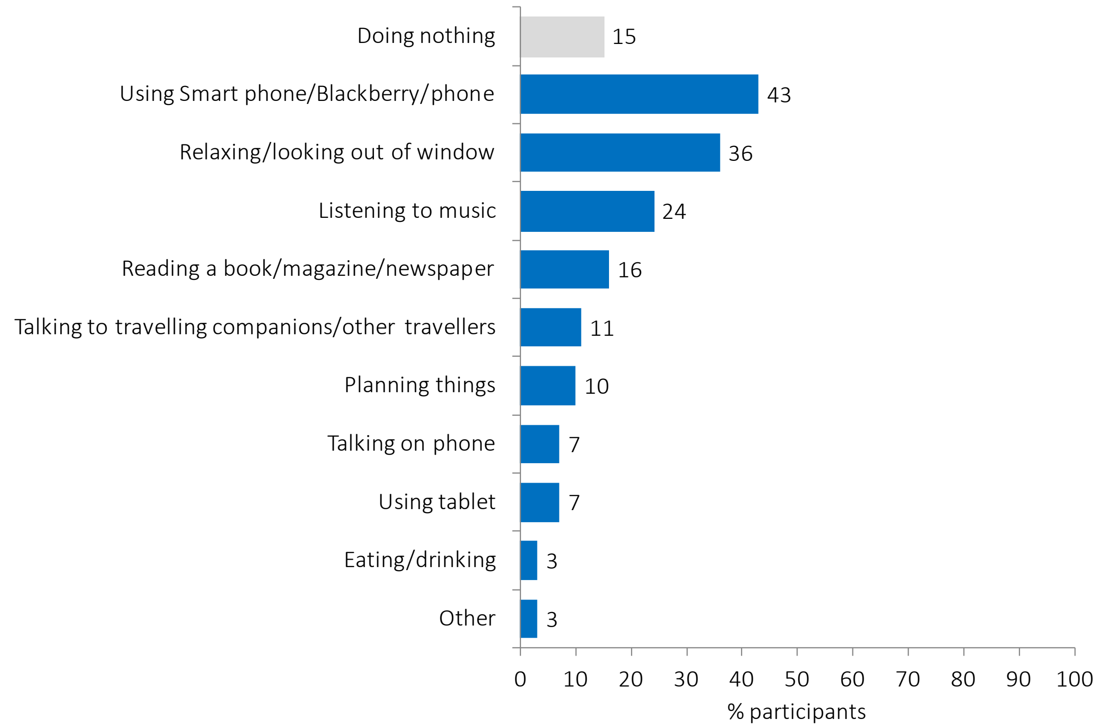
However, counter to this, those who did not use live bus arrival information found the time more enjoyable and productive than those who used live bus arrival information:

		Enjoyable	Productive
•	Used live info	3.35	2.77
•	Did not use live info	4.26	3.23

Activities on the bus

The main activity undertaken on the bus was using smartphone (43%), followed by relaxing or looking out of window (36%), listening to music (24%), reading a book, magazine or newspaper (16%). See Figure 12.

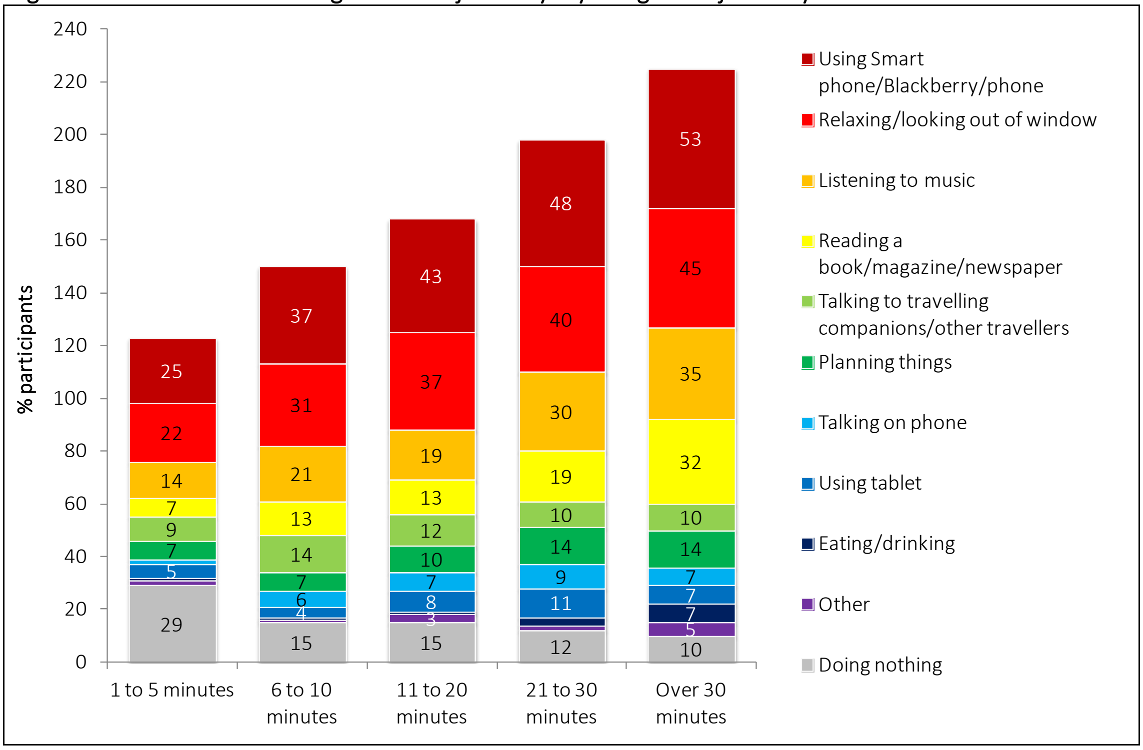
Figure 12: Activities during the bus journey



Weighted base: All participants (1,421)

As would be expected, the longer the journey the more activities were undertaken. Most activities showed a significant increase for trips over 20 minutes compared to trips of 10 minutes or less.

Figure 13: Activities during the bus journey by length of journey



Weighted base: 1 to 5 minutes 153, 6 to 10 minutes 315, 11 to 20 minutes 452, 21 to 30 minutes 252, Over 30 minutes 249

Eating/drinking, reading, talking on the phone and listening to music increased the most with longer journeys.

Doing nothing decreased from 29% for trips of 1-5 minutes to 10% for trips over 30 minutes

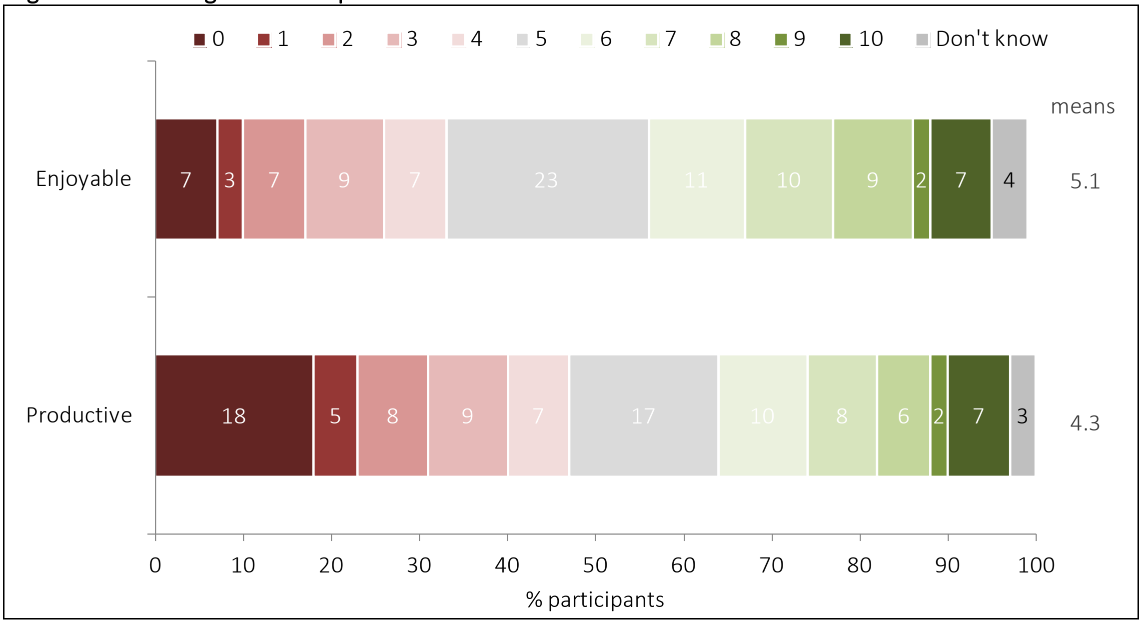
The 85% who undertook activities on the bus stop undertook 1.9 activities each on average. There was a tendency to undertake more activities on the bus the longer the journey.

	activities
• 0 to 2 minutes	1.3
• 3 to 5 minutes	1.6
• 6 to 10 minutes	1.8
• 11 to 15 minutes	2.1
• Over 15 minutes	2.4

Enjoyment and productivity of wait time

Overall, bus users rated time spent on the bus more highly than time at the bus stop, in terms of both how enjoyable (mean score 5.1) and productive (4.3) that time was (compared to 3.7 and 2.9 respectively). Again, the time was thought to have been more enjoyable than productive. See Figure 14.

Figure 14: Rating of time spent on bus



Weighted base: All participants (1,421)

Those who were travelling for leisure purposes found the time significantly more enjoyable and productive than work commuters (mean scores are given below).

	Enjoyable	Productive
• Work commute	4.76	3.97
• Leisure	5.56	4.74

3.6 Bus Trip Characteristics

A number of questions were asked about the bus trip both to provide context for the stated preference research and to collect data to allow for disaggregation of results.

This data covers:

- Journey purpose
- Day of trip
- Weather conditions
- Journey Start Point
- Frequency of Journey
- Whether changes buses
- Bus crowding
- Ticket type
- Group size.

We summarise the findings in this section with Appendix A presenting the results in more detail.

Journey purpose

The survey data was weighted to journey purpose from the Bus User Survey (see Appendix E for details on weighting procedures).

For over half (52%) the journey was a commuting trip. 11% were on leisure trips, 10% on personal business, 10% visiting friends or relatives, 9% shopping, 7% education commuting and 2% on employers business trips.

Weather

On the day of the bus journey, the weather was typically cold, dry and not very windy.

Journey Start Point

For the majority of bus users, the origin of the bus trip was either home (45%) or workplace (21%). Just under a tenth (8%) started their journey from shops or a shopping centre.

Frequency of Journey

Over a third (36%) of bus users said that they make that same journey five or more times a week, reflecting the high proportion of commuters in sample. A fifth (19%) make the journey 1 or 2 times a week and 16% 3 or 4 times a week.

Whether got on first bus

Nearly nine tenths (89%) got on the first arriving bus that went to their destination Around an eighth (11%) decided to wait for another one, typically because the first bus was too crowded (6%).

Whether changed buses

Fifteen per cent changed buses.

Time Spent on Bus

The average time spent on the bus was 22 minutes. A third spend less than 10 minutes on the bus, 32% between 11 and 20 minutes and 36% spent over 20 minutes on the bus.

Group size

A large majority (84%) of participants travelled alone; 16% travelled with others.

Ticket Type

The most common ticket type was Oyster Pay and Go (37%), followed by Oyster Travelcard (35%) and Oyster Bus Pass (11%). 9% used a Freedom or concessionary pass.

Level of Crowding

For the majority of participants (88%), seats were available when they boarded the bus.

For just over a fifth (21%) of bus travellers, the bus got less crowded during the journey; over a quarter (28%) say that it did not change and over half (53%) said that it got more crowded.

Over three quarters (77%) did not have to stand for any part of the bus journey. However, just under a quarter (23%) did; 13% of the total had to stand for the whole journey.

3.7 Participant Demographics

We summarise the characteristics of the sample in this section with Appendix A presenting the results in more detail.

The data was weighted to age and gender from the Bus User Survey (see Appendix E for details on weighting procedures).

Age

The median age band for bus users in the sample was 21-29 years old with 27%. None per cent were aged 17-20 years old. A quarter was aged 30-39, 17% 40-49, 12% 50-59 and 11 over 60 years old.

Gender

Overall, 42% of participants were male and 58% of participants were female.

Employment status

Three quarters of the bus user sample were employed; 67% full-time and 8% part-time. Just over a tenth (11%) were students and 8% were retired.

Annual household income

Annual household income was probed. Just over a fifth (21%) of participants either refused to answer or said they did not know.

The median income band was £20-30,000 with 15%. Under a fifth (17%) had incomes under £20,000, 20% between £30,000 and £50,000 and 25% over £50,000.

Ethnicity

The majority (70%) of participants were from a White background: 44% White British and 26% White other. A tenth each were from a Black or Asian background.

Smartphone

Over nine tenths (91%) of the sample used a smartphone with iPhone (45%) and Android phones (42%) dominant.

4. CONCLUSIONS

The next page summarises the research study highlighting the objectives, the methodology utilised to meet these objectives, the findings broken down for each of the six objectives and the conclusions.

The objectives of this study

The objective of this study is to understand the impact of live bus arrival information on perceived waiting times to understand how perceived waiting time vary across bus travellers and to quantify the relative value of waiting time to in-vehicle time (waiting time multiplier).

Our research methodology

Bus user survey: to gain insights into the impact of live bus information on passengers' perception of waiting time and the likelihood that passengers change their behaviour.

Stated preference survey: embedded in the survey, to quantify the impact of live bus information on passengers' waiting time and the influence of other factors on the waiting

Our evidence (see main text for details)

Live bus arrival information helps passengers manage and reduce their expected waiting time:
- expected waiting time reduced from 8.4 to 4.5 minutes per trip for those who travelled on the low frequency routes;
- and 5.4 to 4.3 minutes per trip for those on the high frequency routes.

The recommended multiplier from this study is 2.0 for bus passenger waiting time 'at stop' vs 'on the bus'. This is calculated from the choice model with a sample weighted to reflect London bus users.
- This is lower than the DfT WebTag value of 2.5 for commuting and other purposes.
- It is an up-to-date, London-specific value

Our models show that the waiting time multiplier differs according to whether the user checks on arrival times and the channel they use
- Haven't checked (2.3)
- Checked using Mobile (1.8)
- Checked using Internet (1.0)
- Checked using both Mobile and Internet (0.8)

56% of those who checked live bus arrival information prior to arriving at the bus stop changed their behaviour based on that information:
- 39% left later than they would have
- 14% chose to use another bus route
- 13% went to a different bus stop

The value of waiting time varies by information channel, the travellers' journey characteristics and demographics
- Journey length, purpose, bus frequency and user age were found to impact on the multiplier.
- We did not find interactions between information channel and other factors

The most common activity undertaken during the wait at stops and on bus was using a phone or smartphone:
- 40% at stop
- 43% on bus.
- 39% did nothing at the stop.

Time spent on the bus was rated more highly than time at the bus stop in terms of how enjoyable and productive it was

Conclusions

We find that where bus customers check live bus information prior to travelling, their expected waiting time is reduced especially for those who travelled on the low service frequency routes. The waiting time (multiplier) varies by the different information channels available (i.e. mobile & Internet), passengers' journey length/purpose and the age of the traveller. The waiting time multiplier calculated from this study and recommended for current use is 2.0. This is a reduction from the current (DfT – UK wide) multiplier of 2.5.

APPENDIX A

Journey details and bus user characteristics

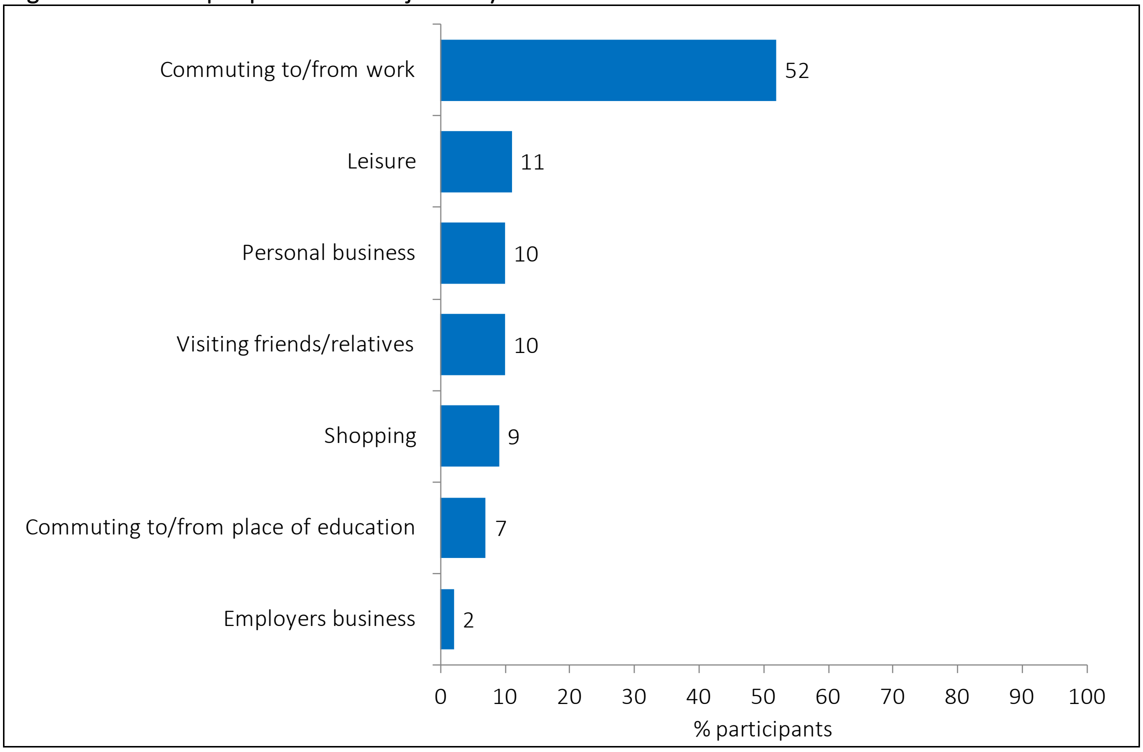
JOURNEY DETAILS

Journey purpose

The survey data was weighted to journey purpose from the Bus User Survey (see Appendix E for details on weighting procedures).

For over half (52%) the journey was a commuting trip.

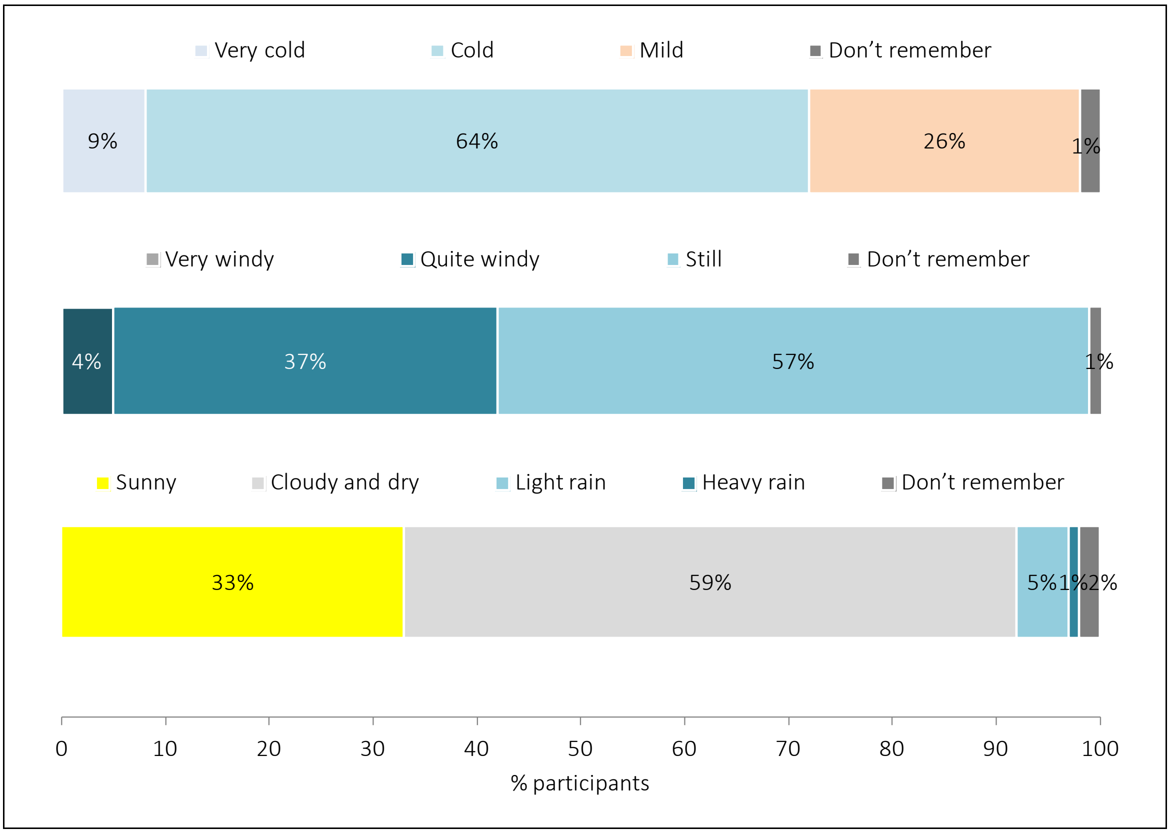
Figure 15: Main purpose of bus journey



Weighted base: All participants (1,421)

Weather

On the day of the bus journey, the weather was typically cold, dry and not very windy.

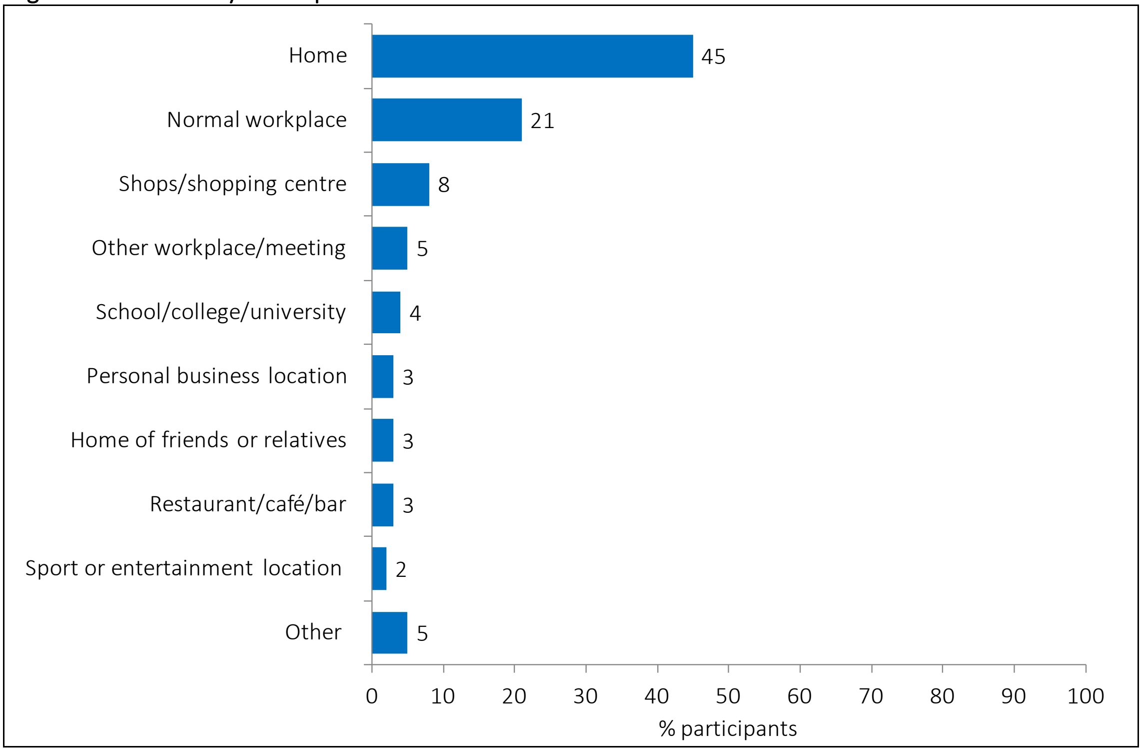


Weighted base: All participants (1,421)

Journey Start Point

For the majority of bus users, the origin of the bus trip was either home (45%) or workplace (21%). Just under a tenth (8%) started their journey from shops or a shopping centre.

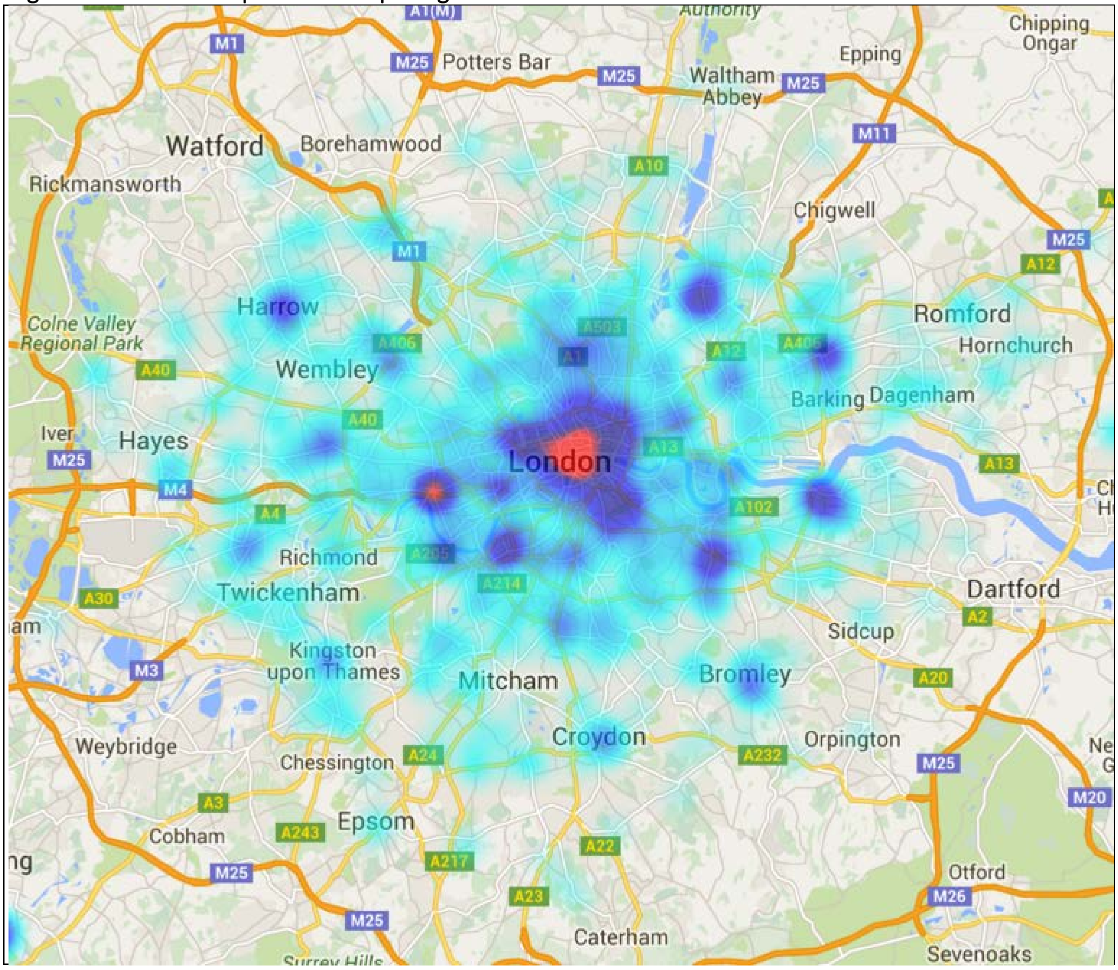
Figure 16: Journey start point



Weighted base: All participants (1,421)

Participants were asked to mark on a map within the software where their journey started and ended. The data was saved as longitude and latitude coordinates in decimal degrees. Figure 17 shows a heat map of the trip origins.

Figure 17: Heat map of bus trip origins

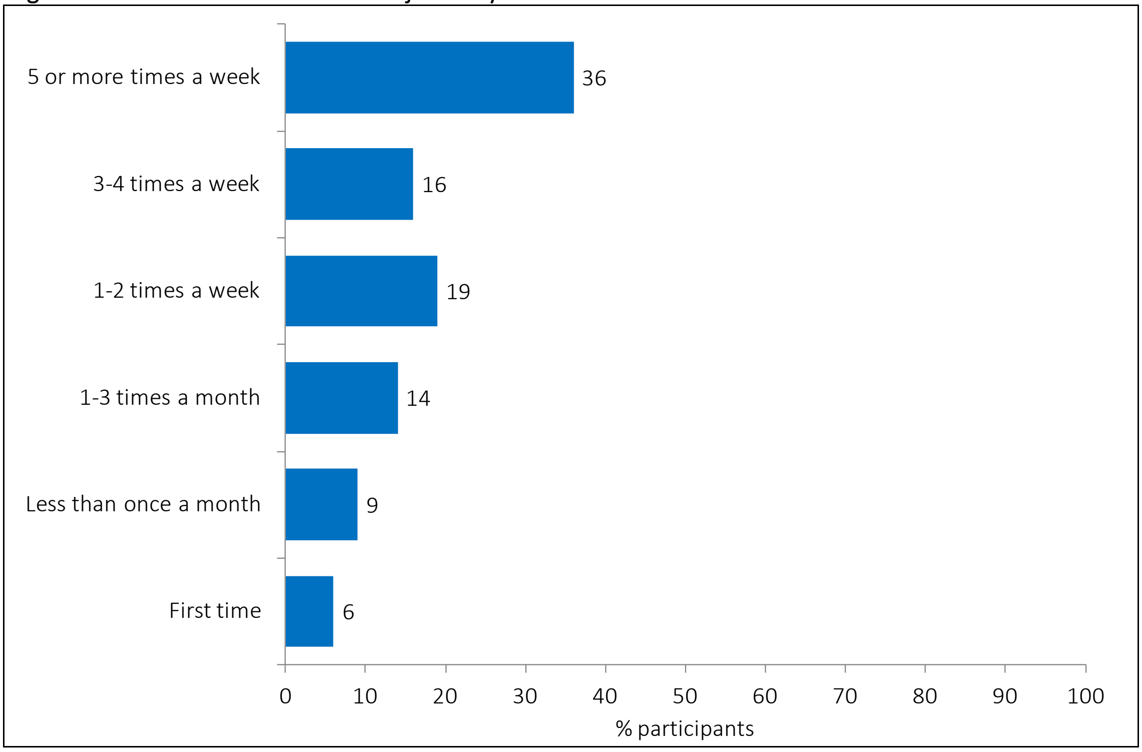


Weighted base: All participants (1,421)

Frequency of Journey

Over a third (36%) of bus users said that they make that same journey five or more times a week, reflecting the high proportion of commuters in sample. A fifth (19%) make the journey 1 or 2 times a week and 16% 3 or 4 times a week.

Figure 18: How often make that journey



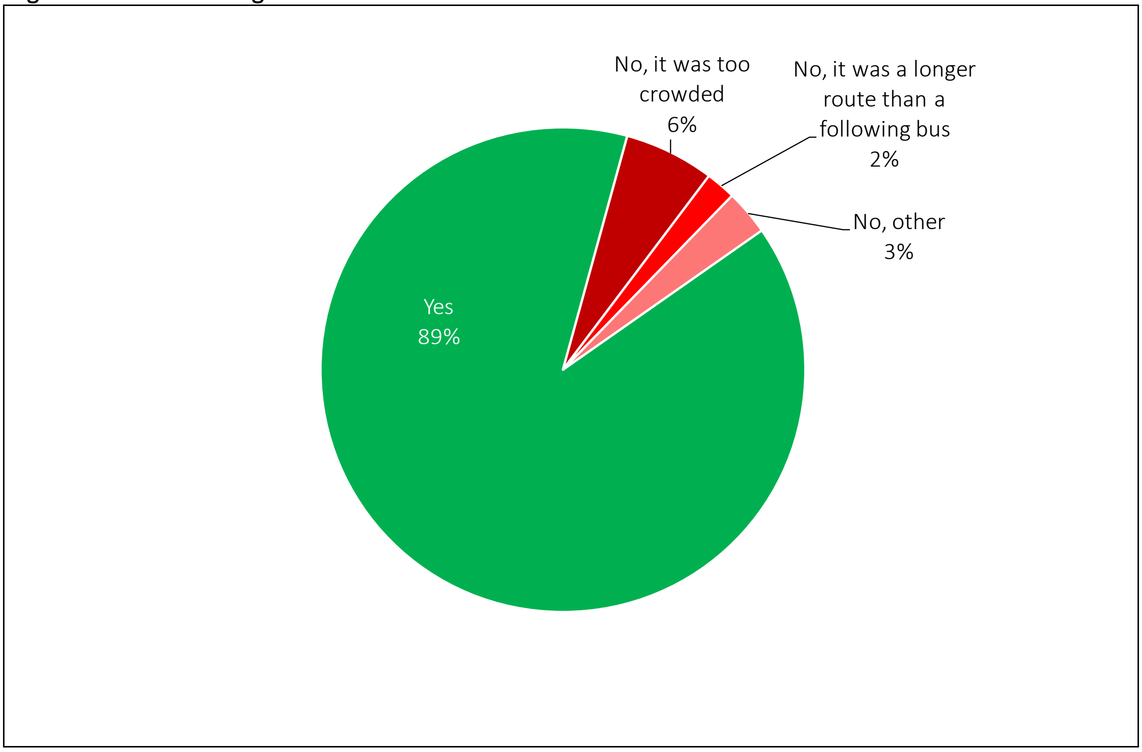
Weighted base: All participants (1,421)

Whether got on first bus

Nearly nine tenths (89%) got on the first arriving bus that went to their destination. Around an eighth (11%) decided to wait for another one, typically because the first bus was too crowded (6%).

Those who used a smartphone app to get live bus arrival information were significantly less likely to get the first bus than those who did not get any live bus arrival information: 87% compared to 92%, indicating they may have used the app to help choose another bus.

Figure 19: Whether got on the first bus that arrived that went to their destination



Weighted base: All participants (1,421)

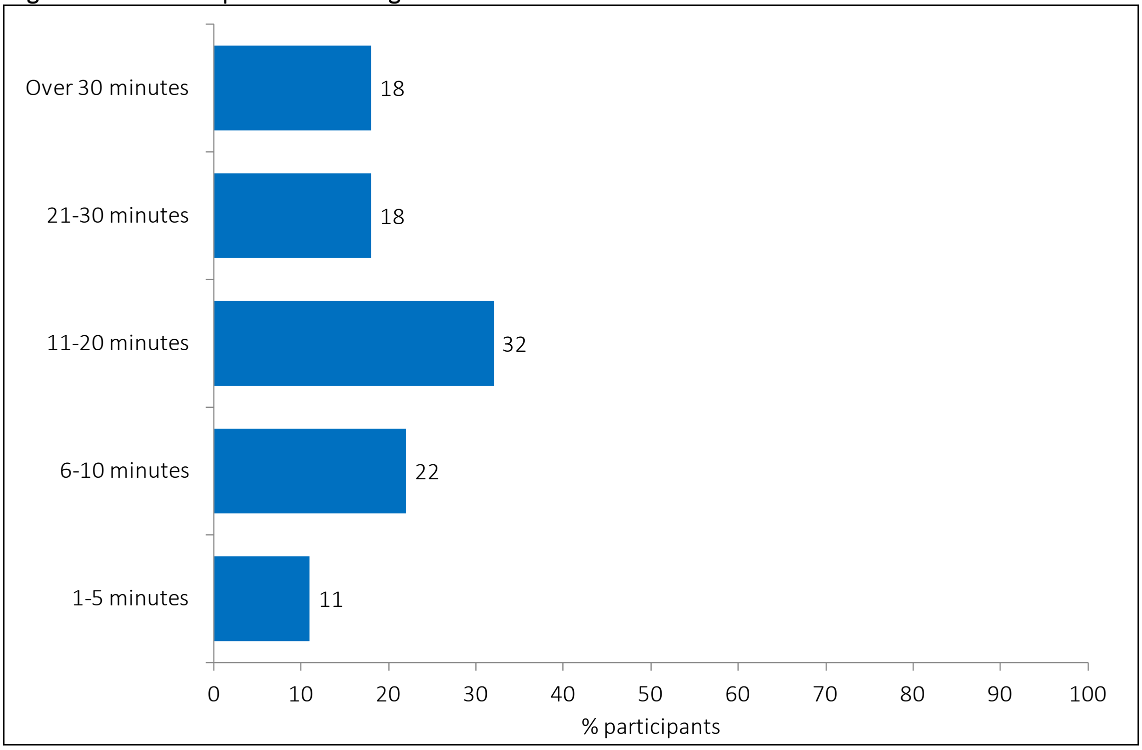
Whether changed buses

Fifteen per cent changed buses.

Time Spent on Bus

The average time spent on the bus was 22 minutes.

Figure 20: Time spent travelling on the bus

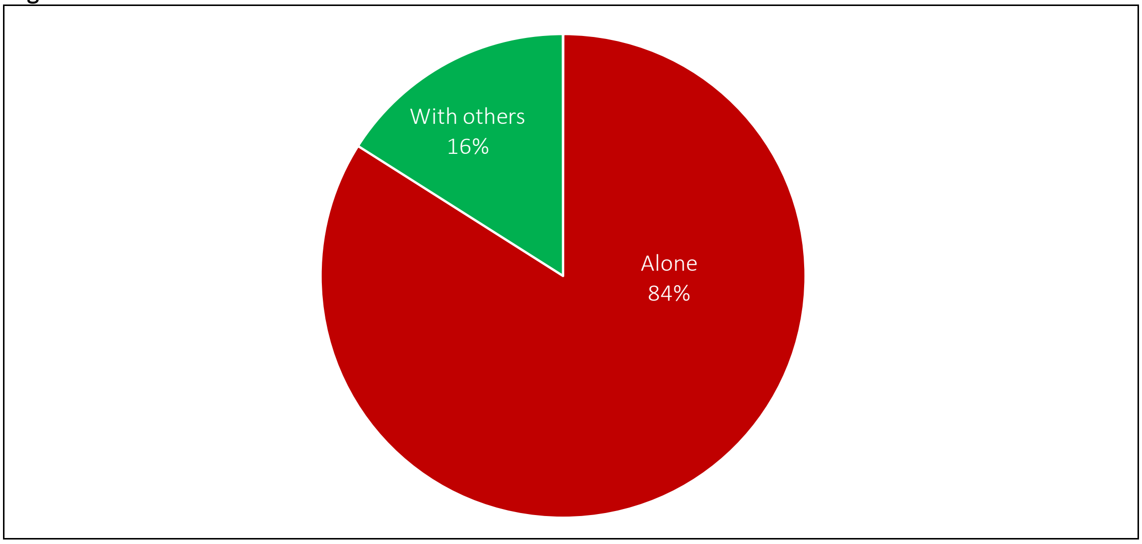


Weighted base: All participants (1,421)

Group size

A large majority (84%) of participants travelled alone; 16% travelled with others.

Figure 21: Whether travelled alone or with others

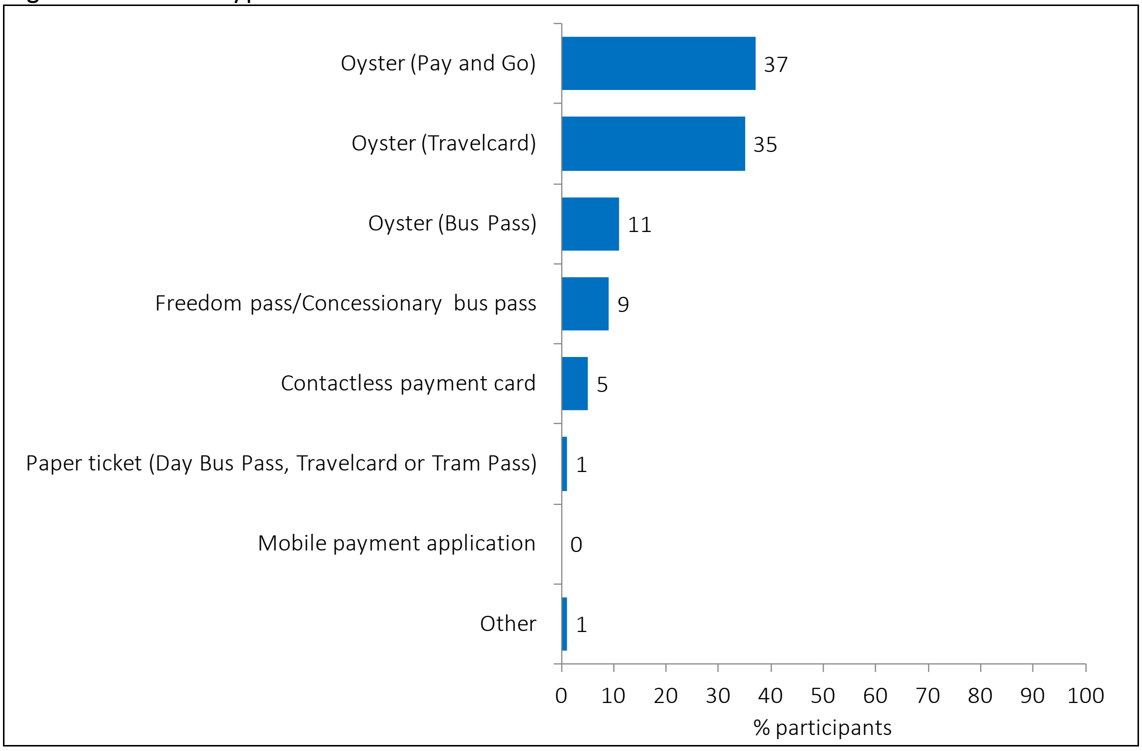


Weighted base: All participants (1,421)

Ticket Type

The most common ticket type was Oyster Pay and Go (37%), followed by Oyster Travelcard (35%) and Oyster Bus Pass (11%).

Figure 22: Ticket type

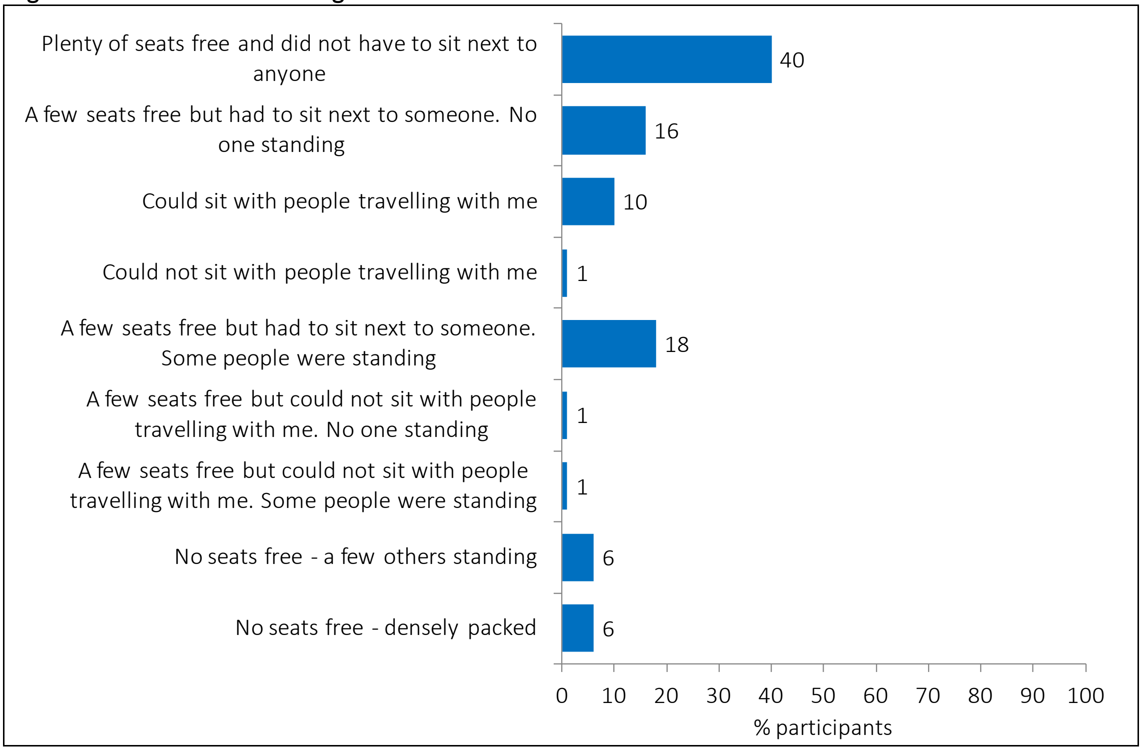


Weighted base: All participants (1,421)

Level of Crowding

For the majority of participants (88%), seats were available when they boarded the bus.

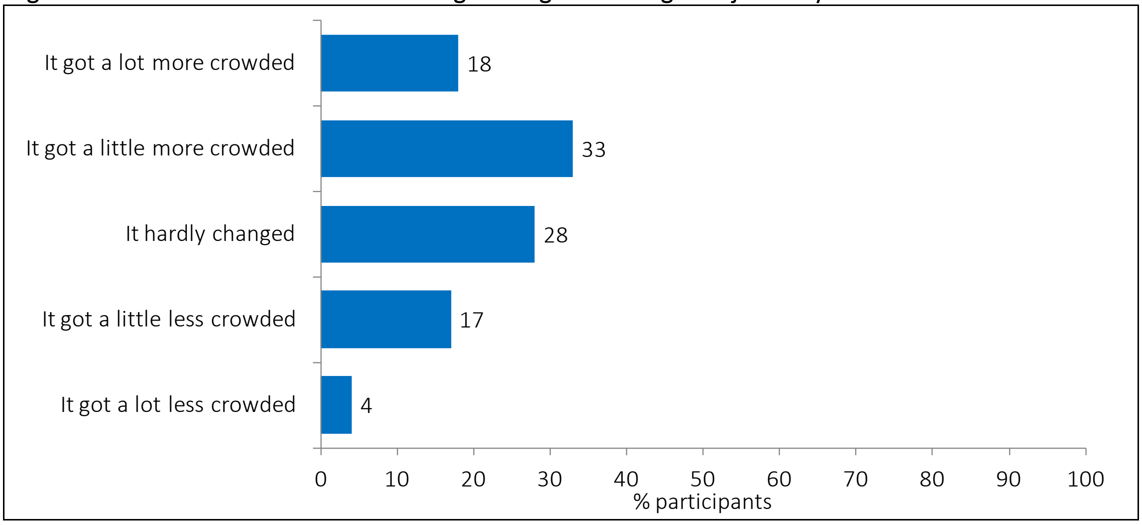
Figure 23: Level of crowing on the bus



Weighted base: All participants (1,421)

For just over a fifth (21%) of bus travellers, the bus got less crowded during the journey; over a quarter (28%) say that it did not change and over half (53%) said that it got more crowded.

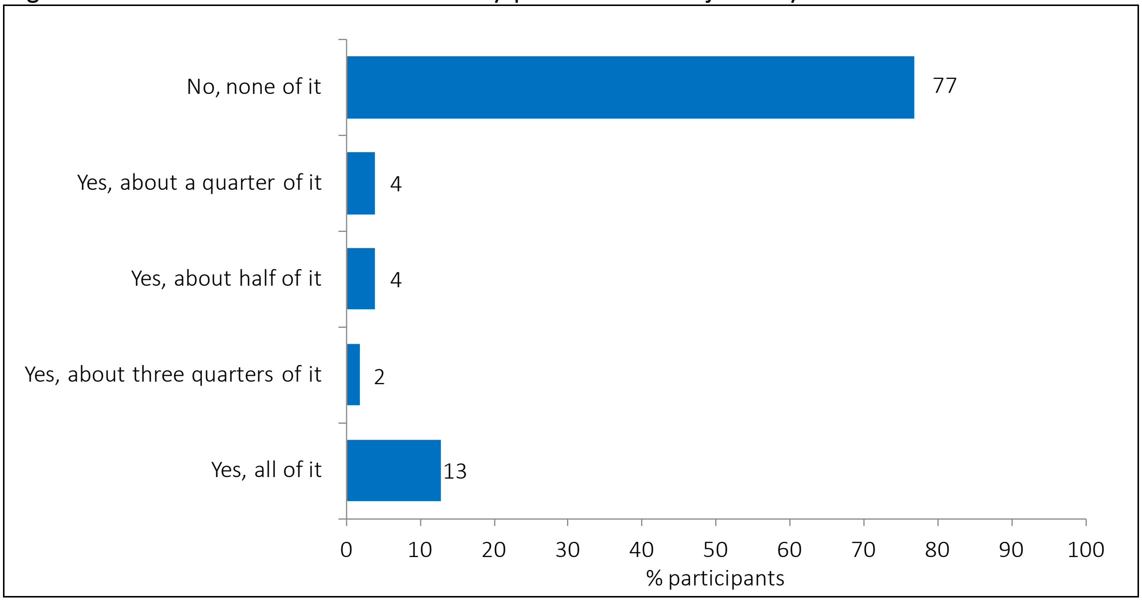
Figure 24: Whether level of crowding changed during the journey



Weighted base: All participants (1,421)

Over three quarters (77%) did not have to stand for any part of the bus journey. However, just under a quarter (23%) did; 13% of the total had to stand for the whole journey.

Figure 25: Whether had to stand for any part of the bus journey



Weighted base: All participants (1,421)

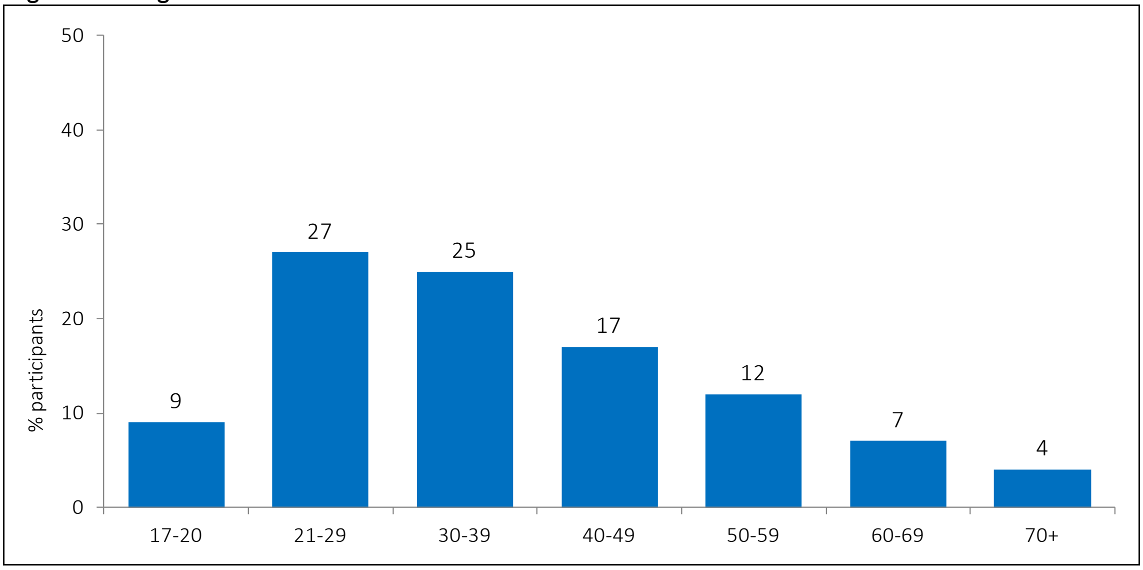
PARTICIPANT DEMOGRAPHICS

The data was weighted to age and gender from the Bus User Survey (see Appendix E for details on weighting procedures).

Age

The median age band for bus users in the sample was 21-29 years old with 27%. None per cent were aged 17-20 years old. A quarter was aged 30-39, 17% 40-49, 12% 50-59 and 11 over 60 years old.

Figure 26: Age band



Weighted base: All participants (1,421)

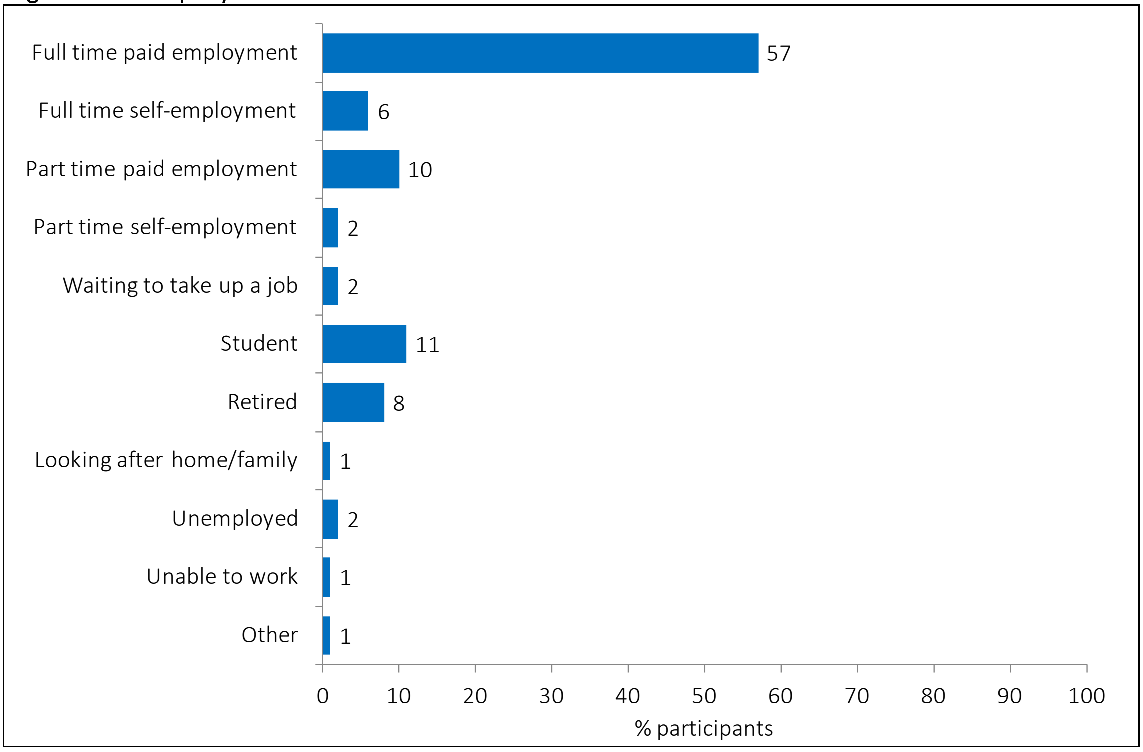
Gender

Overall, 42% of participants were male and 58% of participants were female.

Employment status

Three quarters of the bus user sample were employed; 67% full-time and 8% part-time. Just over a tenth (11%) were students and 8% were retired.

Figure 27: Employment status



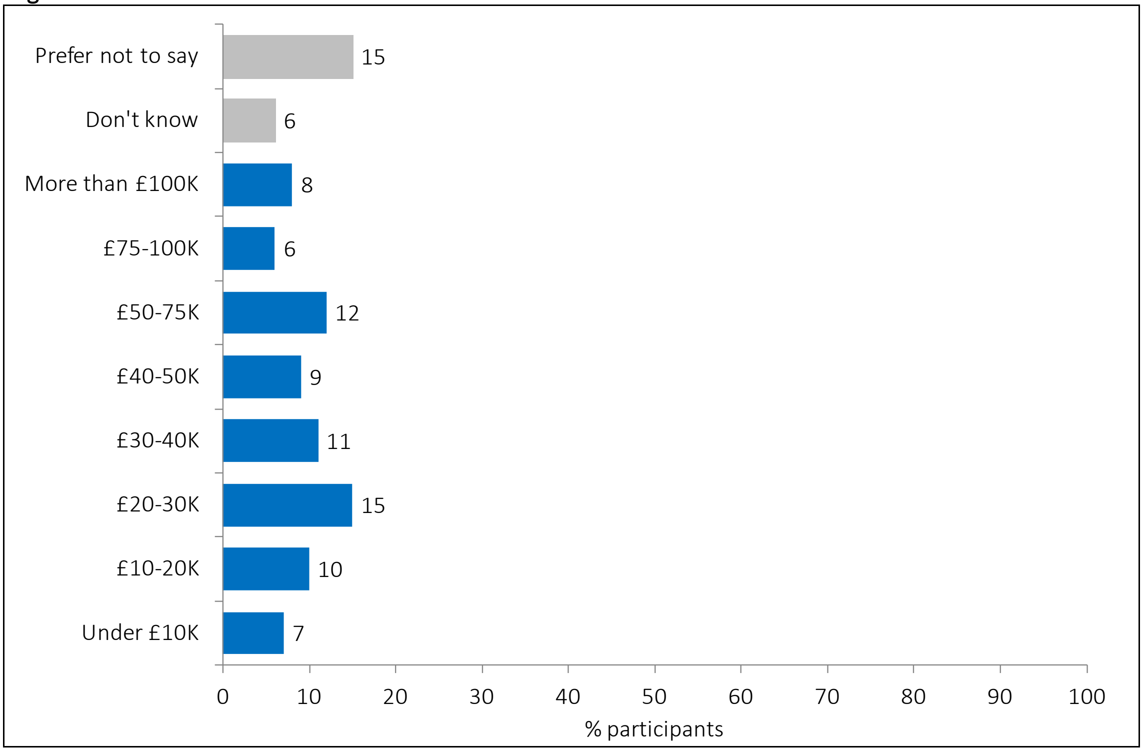
Weighted base: All participants (1,421)

Annual household income

Annual household income was probed. Just over a fifth (21%) of participants either refused to answer or said they did not know.

The median income band was £20-30,000 with 15%. Under a fifth (17%) had incomes under £20,000, 20% between £30,000 and £50,000 and 25% over £50,000.

Figure 28: Annual income of household

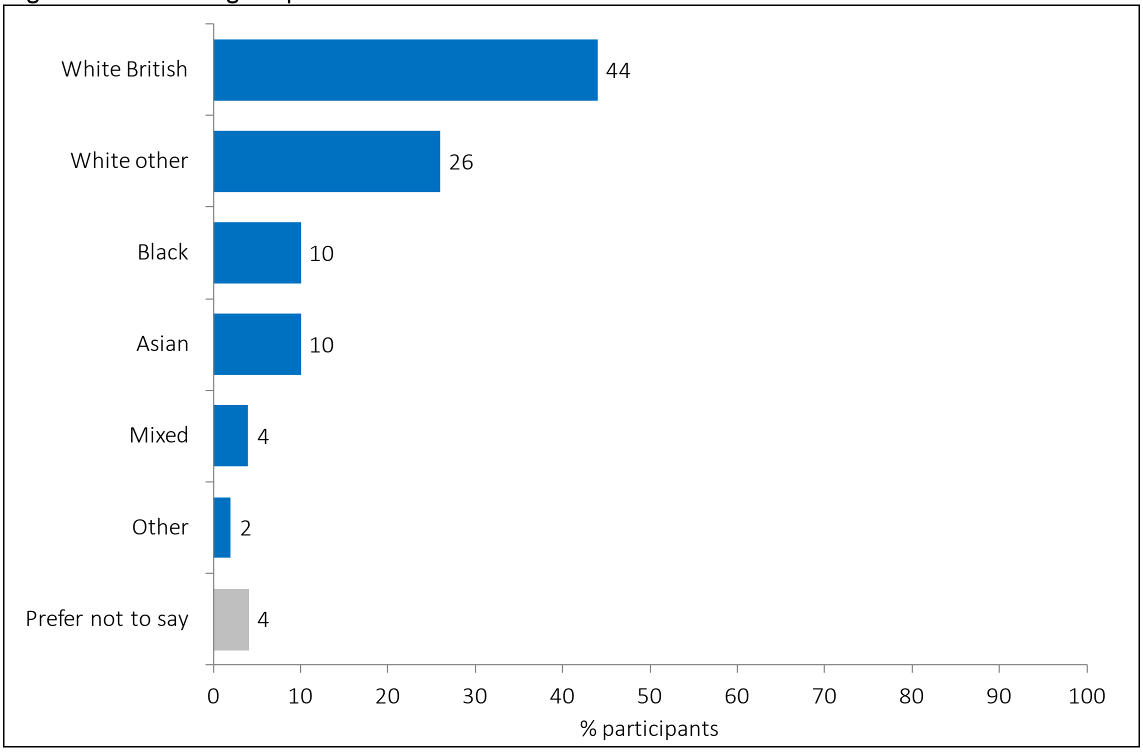


Weighted base: All participants (1,421)

Ethnicity

The majority (70%) of participants were from a White background: 44% White British and 26% White other. A tenth each were from a Black or Asian background.

Figure 29: Ethnic group

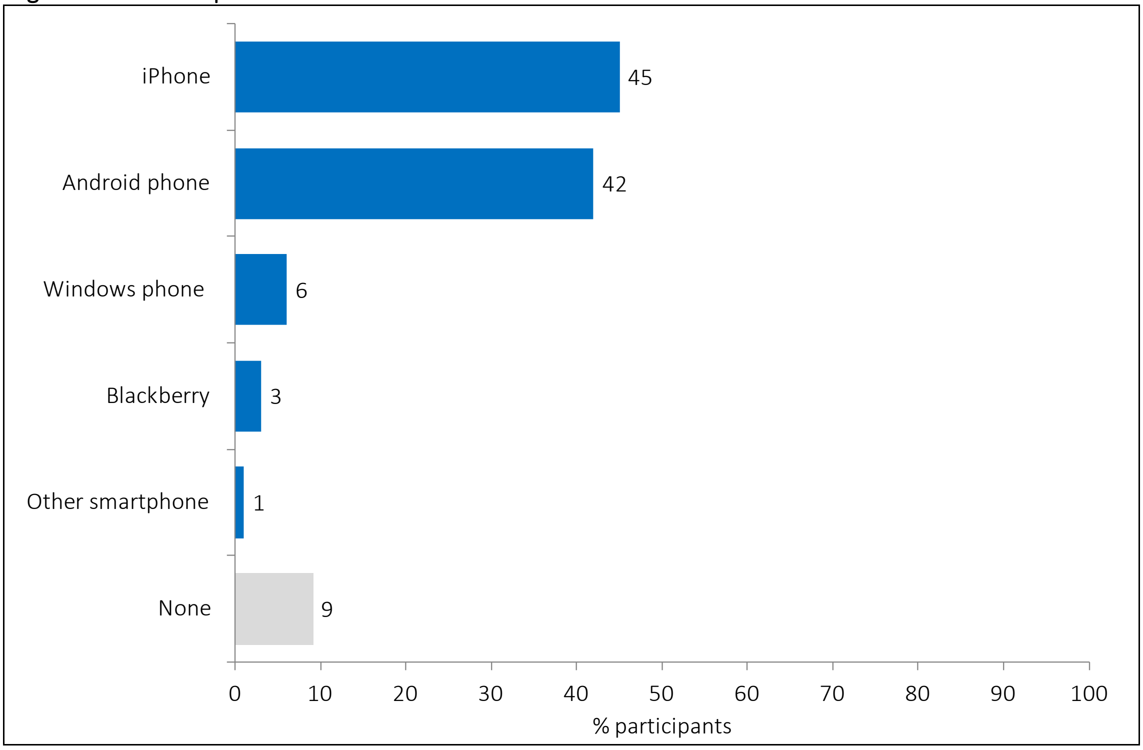


Weighted base: All participants (1,421)

Smartphone

Over nine tenths (91%) of the sample used a smartphone with iPhone (45%) and Android phones (42%) dominant.

Figure 30: Smartphone use



Weighted base: All participants (1,421)

APPENDIX B

Questionnaire

2967
Bus Travel Time

AT BUS STOP RECRUITMENT QUESTIONNAIRE

SYSTEM INFORMATION:
Interviewer number
Interviewer name
Date:
Time interview started:

BUS STOP LOCATION
INTERVIEWER: ENTER LOCATION

1 Holborn Circus / Fetter Lane
2 Portman Street
3 Plumstead Road / Woolwich Public Market
4 Shoreditch High Street
5 Hammersmith Bus Station
6 Harrow Bus Station
7 Holloway Road
8 South Kensington Station
9 Waterloo Bridge / South Bank
10 Streatham St Leonards
11 Ilford Broadway
12 Dunton Road
13 Mile End Station
14 Walthamstow Bus Station
15 Clapham Junction Station / St.John's Hill
16 Westmoreland Road / Sandford Road
17 Lewisham High Street / Rennell Street
18 Brent Park Tesco
19 Treaty Centre
20 Eden Street
21 Sutton Green

COUNTDOWN
INTERVIEWER: ENTER IF COUNTDOWN SIGN AT STOP

Yes
No

Introduction

Good morning/afternoon/evening. My name is .... from Accent and I am carrying out research for TfL into bus travel.

Please be assured that any answers you give will be treated in confidence in accordance with the Code of Conduct of the Market Research Society.

Scoping questions

Q1. Are you waiting for a bus?

Yes
No THANK & CLOSE

Q2. Would you be willing to take part in an online or telephone survey for Transport for London about travel in the Capital regarding and your journey today? The questionnaire will take about 10 minutes and you will be provided with a £5 voucher to thank you for your time.

INTERVIEWER: EXPLAIN VOUCHER WILL BE AWARDED ON COMPLETION OF ONLINE OR TELEPHONE INTERVIEW

Yes, online
Yes, telephone
No **THANK AND CLOSE**

Out of scope **THANK AND CLOSE**

Q3. IF AT COUNTDOWN STOP ASK: Have you looked at the Countdown sign to check your bus arrival time?

Yes
No

Q4. Have you or are you planning to use an app, a website or SMS to check the bus arrival time?

Yes
No

Q5. What is your **main** journey purpose?

Commuting
Business
Other
CHECK QUOTAS

Q6. How did you travel to this bus stop?

Walk all way
Other
CHECK QUOTAS

Q7. In which of these age groups are you? SHOW SCREEN

17-20
21-29
30-39
40-49
50-59
60-69
70+
CHECK QUOTAS

Q8. INTERVIEWER RECORD GENDER:

Male
Female
CHECK QUOTAS

Thank you. You are on scope for this research.

IF Q2=1: We will email you a link for the online survey for you to complete. Can I please take a note of your email address? SHOW SCREEN TO PARTICIPANT AND ASK THEM TO CONFIRM THAT THEIR E-MAIL ADDRESS IS CORRECT
IF Q2=2: We will call you at a convenient time. Can I please take a note of your phone number? SHOW SCREEN TO PARTICIPANT AND ASK THEM TO CONFIRM THAT THEIR PHONE NUMBER IS CORRECT
Name:
IF Q2=1: Email address:
IF Q2=1: Check field for email address (IF NOT MATCHED – GO BACK TO “EMAIL ADDRESS”)
IF Q2=2: Phone number (including STD code)
IF Q2=2: Check field for phone number (IF NOT MATCHED – GO BACK TO “PHONE NUMBER”)

IF Q2=1: Please can I take a note of your phone number where we can contact you for quality control purposes?
Phone number (including STD code)

Interviewer Confirmation

I confirm that this interview was conducted under the terms of the MRS code of conduct and is completely confidential

Yes
No

SYSTEM INFORMATION Time interview completed:

ONLINE RECRUITMENT

SYSTEM INFORMATION: Date: Time interview started:

Introduction

Thank you for clicking on the link.

This questionnaire concerns waiting times for London buses and is being conducted by Accent on behalf of Transport for London.

Please be assured that any answers you give will be treated in confidence in accordance with the Code of Conduct of the Market Research Society.

Q1. When was the last time you caught a bus in London?

Today
Yesterday
2-3 days ago
4-5 days ago
6-7 days ago
8-14 days ago
More than two weeks ago **THANK & CLOSE**
Never caught a bus **THANK & CLOSE**

Q2. Thinking about the most recent day you caught a bus, please answer the following questions. Did you make both an outward **and** a return bus trip?

Yes, one outward and return bus trip
Yes, more than one outward and return bus trip
No, just a single leg bus trip

LEG If Q2=1 or 2 AND RANDOM = 1 LEG = "the outward leg of" If Q2=1 or 2 AND RANDOM = 2 LEG = "the return leg of" If Q2=3 LEG = " "

Q3. What was your **main** journey purpose of #LEG# this bus journey?

Commuting
Business
Other
CHECK QUOTAS

Q4. How did you travel to the bus stop?

Walk all way
Other
CHECK QUOTAS

The rest of the questionnaire may take about 10 minutes to complete. If in response to a question you are unsure of the precise details, please give us an approximate answer if possible.

GO TO Q2 ON MAIN

MAIN CATI/ONLINE QUESTIONNAIRE

Thank you very much for agreeing to complete this on-line survey which is being conducted by Accent on behalf of Transport for London into bus travel. This research is conducted under the terms of the MRS code of conduct and is completely confidential. If you would like to **confirm** Accent's credentials please call the MRS free on 0500 396999.

Any answer you give will be treated in confidence in accordance with the Code of Conduct of the Market Research Society.

The questionnaire will take about 10 minutes to complete. If in response to a question you are unsure of the precise details, please give us an approximate answer if possible.

As a thank you for your time you will be provided with a £5 Amazon, M&S or Boots voucher or we can make a donation of the same amount to a charity.

For convenience you can stop and return to complete the questionnaire as many times as you wish, although once submitted you will not be able to enter again.

LOCATION (FROM RECRUITMENT QUESTIONNAIRE)
DATE (FROM RECRUITMENT QUESTIONNAIRE)
PURPOSE (FROM RECRUITMENT QUESTIONNAIRE):
IF PURPOSE=1 RQPURPOSE = "commuting"
IF PURPOSE=2 RQPURPOSE = "business"
IF PURPOSE=1 RQPURPOSE = " "

Details of bus journey

Q1. **IF ON STREET RECRUITED:** When we contacted you in #LOCATION# on #DATE#, you were in the course of making a bus journey.

Were you on the outward or return part of your journey?
Outward (for example from home)
Return
Single journey only

LEG:
IF Q1=1 LEG="outward"
IF Q1=2 LEG="return"
IF Q1=3 LEG=""

LEG2:
IF Q1=1 LEG2 OR ONLINE SAMPLE LEG = 1 ="the outward part of your"
IF Q1=2 LEG2 OR ONLINE SAMPLE LEG = 2 ="the return part of your"
IF Q1=3 LEG2 OR ONLINE SAMPLE LEG = 3 ="your"

Q2. **IF Q1=1 (OUTWARD) OR ONLINE SAMPLE LEG = 1 ASK:** Where did the outward part of your journey start?
IF Q1=2 (RETURN LEG) OR ONLINE SAMPLE LEG = 2 ASK: Where did the return part of your journey start?
IF Q1=3 (SINGLE) OR ONLINE SAMPLE LEG = 3 ASK: Where did your journey start?

Home
School/college/university
Normal workplace
Other workplace/meeting
Shops/shopping centre
Restaurant/café/bar
Home of friends or relatives
Sport or entertainment location (eg cinema)
Personal business location (eg hospital, bank)
Other (**please type in**)

Q3. At what time did you arrive at the bus stop? **24 HOUR CLOCK, for example 2pm is 14:00. IF YOU DON'T KNOW PLEASE ESTIMATE**

Q4. **IF ONLINE SAMPLE**: In which part of London did you board the bus?

Q5. Where did you board the bus for #LEG2#journey? Click on the map below to show the starting location🛈[9]

Q6. And where did you get off the bus for #LEG2# journey? Click on the map below to show the destination🛈1 **PROBE LOCATION**

CHECK: IF Q5=Q6. IF SO ASK PARTICIPANT TO CHECK RESPONSES

Q7. On what day of the week was the bus journey?

Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

---

[9] HOVER BUTTON WITH FOLLOWING TEXT: You can zoom in by clicking on the map or by using the zoom controls to the left of the map. You can move the location by clicking and dragging or by using the controls on the top left of the map.
When you have located the location click on the forward arrow at the bottom of the screen

Q8. What was the **main** purpose of your bus journey?

Commuting to/from work
Commuting to/from place of education
Employers business
Shopping
Visiting friends/relatives
Sport/entertainment
Other leisure
Personal business

Q8a What number bus did you catch?

Don't remember

Q8b Did you get on the first bus that arrived that went to your destination?

Yes
No, it was too crowded
No, it was a longer route than a following bus
No, other (please type in)

Q9. Did you change buses?

Yes
No

Q10. How long did you spend travelling on the #Q8A# bus? **IF YOU DON'T RECALL PLEASE GIVE YOUR BEST ESTIMATE**

… ..Minutes
RANGE 1- 120

Q11. On average, how often do you make this journey?

5 or more times a week
3-4 times a week
1-2 times a week
1-3 times a month
Less than once a month
First time

Q12. Did you travel alone or with others?

Alone
With others

Q13. What form of ticket did you use?

Oyster (Pay and Go)
Oyster (Bus Pass)
Oyster (Travelcard)
Contactless payment card
Mobile payment application (eg Apple Pay, Barclaycard Contactless Mobile, bPay, Tag, Wristband)
Paper ticket (Day Bus Pass, Travelcard or Tram Pass)
Freedom pass/Concessionary bus pass
Other (please type in)

Q14. What was the weather like? **PLEASE TICK ONE FROM EACH CATEGORY READ OUT**

Dry/rain

Sunny
Cloudy and dry
Light rain
Heavy rain
Wind
Very windy
Quite windy
Still
Temperature
Very cold
Cold
Mild
Hot

Other (please type in)
Don't remember

Bus waiting time information

Q16. Did you use any of the following to get live bus arrival time information? **READ OUT** *MULTI RESPONSE*

Smartphone/Tablet app (eg London Bus Live Countdown, Live London Bus Tracker, Citymapper, Google Maps etc)
Internet site (eg Live bus arrivals, Journey Planner etc)
SMS (eg text to 87287 with bus stop code)
No, none of the above **GO TO Q16A**

Q16a **IF Q16_4=1 (NO, NONE OF THE ABOVE) ASK:** How did you plan your arrival time to the stop?

I didn't, I just turned up
I know when the bus is due to arrive
I know the bus is frequent so I just turned up.
Other **(please type in)**
GO TO Q21

Q17. Did you check live bus arrival time information **before** you got to the bus stop?

Yes
No **GO TO Q21**

Q18. **IF Q17=1 (YES) ASK:** Where did you check live bus arrival time information? *MULTI RESPONSE*

At home
At workplace
At restaurant, café, bar
On street
On train, tram or other bus
Other (please type in)

Q19. Did checking live bus arrival time information before you got to the bus stop lead you to doing any of the following? **READ OUT**

Leave later than you would have
Go to a different stop
Use another bus route
Use another means of travel
No

Q20. How accurate would you say the live bus arrival time information was?

Spot on
1-2 minutes out
3-5 minutes out
More than 5 minutes out

Details of wait at stop

Q21. Before arriving at the bus stop, how long did you expect to have to wait for the bus at the stop?

Minutes
RANGE 1- 60

Q22. Did the stop have a Countdown sign?

Yes
No

Q23. **IF Q22=1 (YES) ASK:** Did you refer to the Countdown sign to check your bus arrival time?

Yes
No

Q24. How long did you wait at the bus stop before your bus arrived? **IF YOU DON'T RECALL PLEASE GIVE YOUR BEST ESTIMATE.**

Minutes
RANGE 1- 60

Activities at bus stop

Q25. You said you waited #Q24# minutes for the bus at the bus stop. In that time, which of the following activities did you do: READ OUT *MULTI RESPONSE*

Using tablet (eg to read, watch TV, browse the internet, email, use social media etc)
Using Smart phone/Blackberry/phone (eg to browse the internet, email, use social media etc)
Talking on phone
Reading a book/magazine/newspaper
Eating/drinking
Talking to travelling companions/other travellers
Listening to music
Planning things
Relaxing
Doing nothing
Other

Q25B **IF MORE THAN ONE MENTIONED AT Q25 ASK:** And what do you spend most of your time doing at the bus stop? PROMPT

ALL TICKED IN Q25

Q25C SCALE

Q25D Thinking about what you did at the bus stop, how productive would you say this time was? READ OUT SCALE

0 – It was completely unproductive
1
2
3
4
5
6
7

8
9
10 – It was very productive
Don't know

Q25e And how enjoyable would you say this time was? **READ OUT SCALE**

0 – It was completely unenjoyable
1
2
3
4
5
6
7
8
9
10 – It was very enjoyable
Don't know

Activities on bus

Q26. You said that your one way bus journey took #Q10# minutes. In that time, which of the following activities did you do? **READ OUT** *MULTI RESPONSE*

Using tablet (eg to read, watch TV, browse the internet, email, use social media etc)
Using Smart phone/Blackberry/phone (eg to browse the internet, email, use social media etc)
Talking on phone
Reading a book/magazine/newspaper
Eating/drinking
Talking to travelling companions/other travellers
Listening to music
Planning things
Relaxing/looking out of window
Doing nothing
Other

Q27. **IF MORE THAN ONE MENTIONED AT Q26 ASK:** And what do you spend most of your time doing on your journey? **PR0MPT**

ALL TICKED IN Q26

Q28.

Q29. Thinking about what you did on the bus, how productive would you say this time was? **READ OUT SCALE**

0 – It was completely unproductive
1
2
3
4
5
6
7
8
9
10 – It was very productive
Don't know

Q30. And how enjoyable would you say this time was? **READ OUT SCALE**

0 – It was completely unenjoyable
1

2
3
4
5
6
7
8
9
10 – It was very enjoyable
Don't know

Q31. When you boarded the bus, how crowded was it? PROMPT

IF SOLUS (IE Q12=1): Plenty of seats free and did not have to sit next to anyone
IF SOLUS (IE Q12=1): A few seats free but had to sit next to someone. No one standing
IF NOT SOLUS (IE Q12=2): Could sit with people travelling with me
IF NOT SOLUS (IE Q12=2): Could **not** sit with people travelling with me
IF SOLUS (IE Q12=1): A few seats free but had to sit next to someone. Some people were standing
IF NOT SOLUS (IE Q12=2): A few seats free but could not sit with people travelling with me. No one standing
IF NOT SOLUS (IE Q12=2): A few seats free but could not sit with people travelling with me. Some people were standing
No seats free – a few others standing
No seats free – densely packed

Q32. As the journey progressed, did the crowding level change? PROMPT

It hardly changed
It got a little more crowded
It got a lot more crowded
It got a little less crowded
It got a lot less crowded

Q33. Did you stand for any part of your bus journey? PROMPT

Yes, all of it
Yes, about three quarters of it
Yes, about half of it
Yes, about a quarter of it
No, none of it

Stated preference

Please imagine that you are making the same journey again, under the same circumstances.

We would now like you to consider a series of situations where you have a choice between two different bus options for that journey but that the expected waiting time for the bus and the travel time on the bus may differ.

Please imagine that these are the options and information available to you and indicate which of the bus options you would chose for this journey, or whether you would decide not to use either bus under the conditions presented.

Choice Scenario 1

	Journey A	Journey B	I would not travel by bus
Expected Waiting Time	8 mins	5 mins	
Expected Journey Time	10.5 mins	15 mins	

Choice	○	○	○

Diagnostics

Q34. Were you able to understand the choice situations as they were presented?

Yes
No

Q35. How easy did you find it choosing between the options above?

Very easy
Moderately easy
Moderately difficult
Very difficult

Q36. When considering the options which of the following factors did you consider?

Expected waiting time
Expected journey time
Total time
None of above

Classification Questions

We would now just like to ask a few questions which will help us to understand some of the information you have provided us with. Please be assured that all details you give will be treated with the strictest confidence.

Q37. In which of the following age categories are you in? READ OUT

17-20
21-29
30-39
40-49
50-59
60-69
70+

Q38. What is your gender?

Male
Female

Q39. What is your employment status?

Full time paid employment
Part time paid employment
Full time self-employment
Part time self-employment
Student
Waiting to take up a job
Unemployed
Unable to work
Retired
Looking after home/family
Other

Q40. We would now like you to think about the annual income of your **household** as a whole. This question is being asked because TfL want to understand how the responses to the survey vary by income. Please note that, like all information in this survey, this data will be confidential and used for analysis purposes only. Which of the following best represents the gross annual income, before deductions for tax and National Insurance, for your household? **READ OUT**

Under £10K
£10-20K
£20-30K
£30-40K
£40-50K
£50-75K
£75-100K
More than £100K
Don't know
Prefer not to say

Q41. To which of these ethnic groups do you consider you belong? **READ OUT**

A: WHITE
British
Irish
Any other White background
B: MIXED
White and Black Caribbean
White and Black African
White and Asian
Any other Mixed background
C: ASIAN OR ASIAN BRITISH
Indian
Pakistani
Bangladeshi
Any other Asian background
D: BLACK OR BLACK BRITISH
Caribbean
African
Any other Black background
E: CHINESE OR OTHER ETHNIC GROUP
Chinese
Any other ethnic group
Prefer not to say

Q41b Which of the following smartphone devices do you use?

None
Apple e.g. iPhone
Blackberry
Android phone e.g. Samsung Galaxy
Windows phone e.g. Microsoft Lumia
Other smartphone (please specify)

Q42. **IF ON STREET RECRUITED:** That was the last question. Thank you very much for taking part in this research.

Accent, on behalf of TfL, would like to thank you for taking the time to complete this questionnaire. As mentioned, we will provide you with a £5 Amazon, Boots or M&S voucher or make a donation to a charity on your behalf. Charity donations will be to MacMillan Cancer Support (charity number 261017). Please tell us which you would prefer?

Amazon voucher
Boots voucher
M&S voucher
Charity donation **GO TO Q44**

Q43. **IF ON STREET RECRUITED: Q42=1 OR 3 ASK:** We will send your #Q42# to an email address, or if you prefer, to a postal address. You should receive it by the end of April. Please either enter your email address or full name and postal address if you would prefer it to be posted.
Q42=2 ASK: We will post the Boots voucher to your postal address. You should receive it within four weeks. In order for us to do so, please enter your full name and postal address.

IF Q42=1 or 3: Email address: **please type in** Postal address: **please type in**
IF Q42=2: Postal address: **please type in**

Q44. We really appreciate the time that you have given us today. Would you be willing to be contacted again for clarification purposes or be invited to take part in other research for Transport for London?

Yes, for both clarification and further research
Yes, for clarification only
Yes, for further research only
No

Thank you for your help in this research

Thank you. This research was conducted under the terms of the MRS code of conduct and is completely confidential.

SYSTEM INFORMATION
Time interview completed:

APPENDIX C

Methodology

At bus stop recruitment

Interviewers recorded refusals, out of scopes and the number of interviews achieved for each hour period during their shift. They also recorded any comments about factors which might affect the fieldwork.

Bus stops were chosen to represent a range of types covering:

- Whether Countdown or not
- High and low frequency bus services
- Spread of zones
- Spread of geographic location.

The list of 21 stops chosen is shown below. Maps of each stop are shown in Appendix C.

#	Stop Name	Count-down	Zone	Borough	Low freq.
1	Holborn Circus / Fetter Lane		1	City of London	0
2	Portman Street		1	City of Westminster	0
3	Plumstead Road / Woolwich Public Market		4	Greenwich	0
4	Shoreditch High Street	Y	1	Hackney	0
5	Hammersmith Bus Station	Y	2	Hammersmith and Fulham	0
6	Harrow Bus Station		4	Harrow	0
7	Holloway Road	Y	2	Islington	0
8	South Kensington Station		1	Kensington and Chelsea	0
9	Waterloo Bridge / South Bank		1	Lambeth	0
10	Streatham St Leonards	Y	3	Lambeth	2
11	Ilford Broadway	Y	4	Redbridge	0
12	Dunton Road	Y	2	Southwark	0
13	Mile End Station	Y	2	Tower Hamlets	0
14	Walthamstow Bus Station		4	Waltham Forest	2
15	Clapham Junction Station / St.John's Hill	Y	2	Wandsworth	2
16	Westmoreland Road / Sandford Road		4	Bromley	3
17	Lewisham High Street / Rennell Street		3	Lewisham	3
18	Brent Park Tesco		3	Brent	5
19	Treaty Centre		4	Hounslow	5
20	Eden Street		4	Kingston upon Thames	5
21	Sutton Green	Y	4	Sutton	5

All locations were covered for two shifts except the following which were covered for one shift:

- 2 Portman Street
- 6 Harrow Bus Station
- 9 Waterloo Bridge/South Banks
- 10 Streatham St Leonards
- 13 Mile End Station
- 16 Westmoreland Road/Sandford Road

The scheduled 35 shifts took place between 12 and 24 March 2016. An additional two shifts were undertaken on 29 March to increase the response.

Overall, 1,397 recruitment interviews were undertaken (target = 1,400) with 1,156 emails and 241 phone recruits

Quotas were broadly met:

- Main journey purpose: commuting 48% (minimum 40%)
- Access mode to stop: walk 49% (minimum 50% walk)
- Age:
  - under 29 years 39% (minimum 20%)
  - 30-49 years 41% (minimum 25%)
  - 50+ years 20% (minimum 15%)
- Gender:
  - Male 39% (minimum 40% male)
  - Female 61%

CATI interviews took place from 17 March to 3 April. There were 241 numbers uploaded to the telephone unit and 97 interviews undertaken.

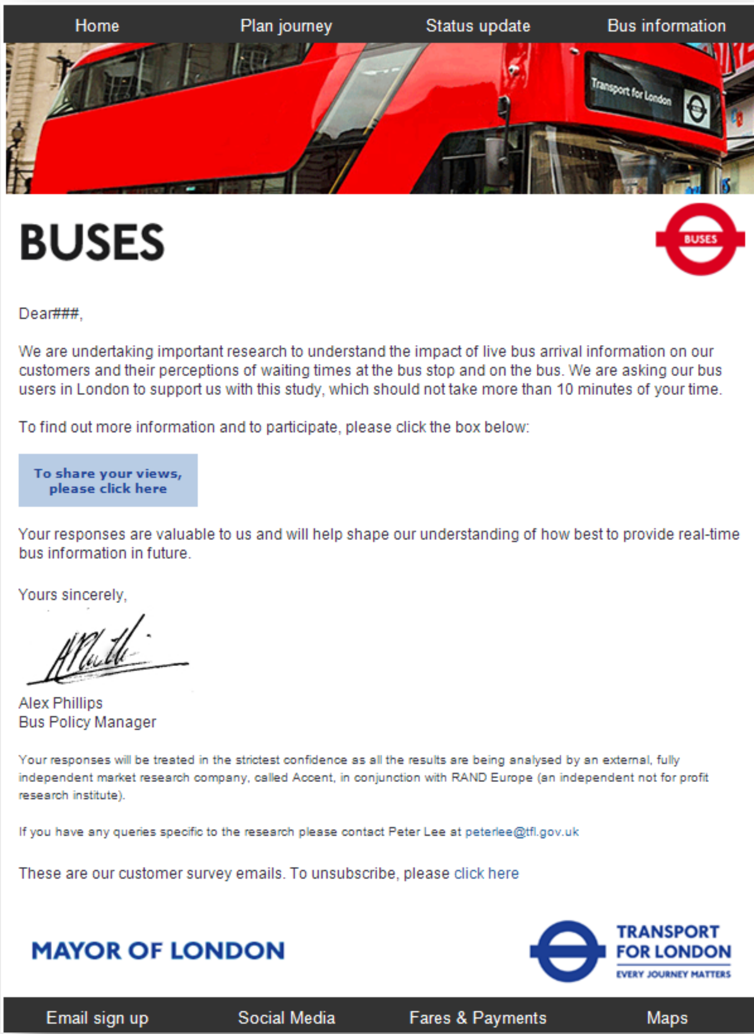
The average interview length by phone was 17 minutes.

Oystercard Sampling Method

TfL sampled their database of Oystercard holders by selecting those who had used bus at least twice in the preceding eight weeks.

Potential participants were sent emails with a link to an online survey.

The online survey included scoping questions to ensure that the participants had made a recent bus trip within last two weeks.



Home | Plan journey | Status update | Bus information

BUSES

Dear###,

We are undertaking important research to understand the impact of live bus arrival information on our customers and their perceptions of waiting times at the bus stop and on the bus. We are asking our bus users in London to support us with this study, which should not take more than 10 minutes of your time.

To find out more information and to participate, please click the box below:

To share your views, please click here

Your responses are valuable to us and will help shape our understanding of how best to provide real-time bus information in future.

Yours sincerely,

Alex Phillips
Bus Policy Manager

Your responses will be treated in the strictest confidence as all the results are being analysed by an external, fully independent market research company, called Accent, in conjunction with RAND Europe (an independent not for profit research institute).

If you have any queries specific to the research please contact Peter Lee at peterlee@tfl.gov.uk

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A sample of at least 1,000 completes were aimed for and 1,006 completes were achieved. 693 entered the survey but did not complete, with 221 just opening the landing page and not proceeding further. The average questionnaire completion length was 13 minutes.

APPENDIX D

Pilot Report

2967 Value of Time for Bus Passengers – pilot report

Background

The key driver for bus user satisfaction is reliability which is comprised of journey time and the time waited to catch the bus. The latter is very much influenced by passenger perceptions of waiting times.

Currently, bus passenger waiting time is valued at 2.5 times the value of in-vehicle journey time. This factor is used in business cases for service changes.

It is thought that recent technological changes allowing for many bus passengers to access 'live' waiting time (through Countdown, Smartphone or tablet apps, the internet and SMS) when waiting for buses or even before arrival at the stop may reduce the negative impact of waiting time. In addition, the availability of such information may lead to behavioural change, for example, delay leaving home or work (this reducing the time waiting at the stop), walking to the next stop, doing something else like shopping, changing route or mode.

Therefore, research is required to assess whether there is a case for adjusting the wait time multiplier and, if so, to what.

Although Countdown has been available at bus stops since 1992, the real explosion in waiting time information has been much more recent with the boom in Smartphone use with associated travel apps.

TfL wishes to understand the impact of live bus arrival information on perceived waiting times to ensure the continued accuracy of the multiplier and the process itself.

Methodology

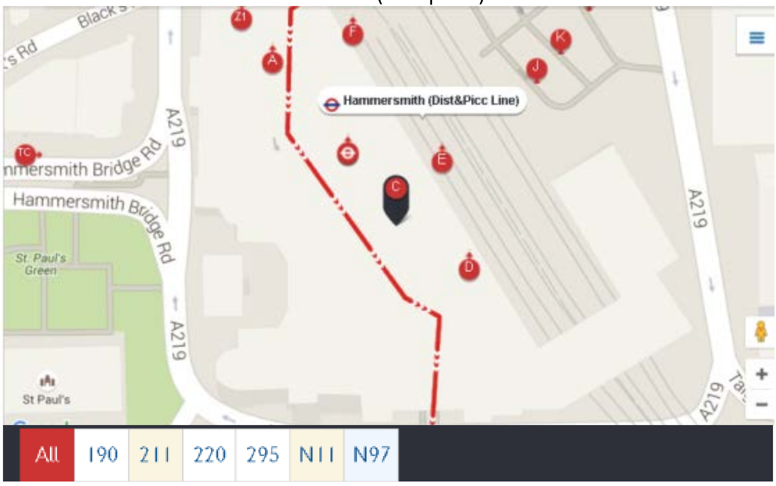
Two methods were adopted:

- at bus stop recruited bus users (with a follow up online or telephone survey)
- online interviews with a sample of bus users supplied by TfL from their Oyster user database

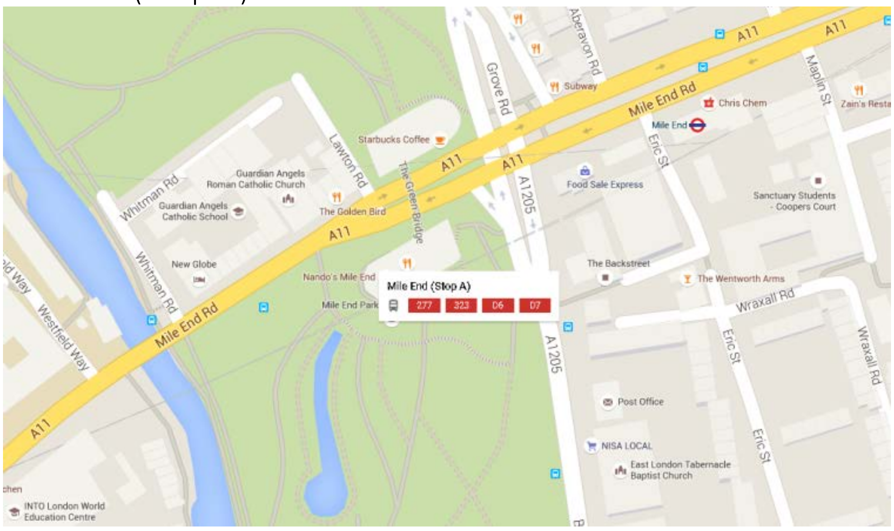
At bus stop recruited bus users

The pilot intercept CAPI survey was administered face-to-face using Android tablets at the following locations on Friday 26 February:

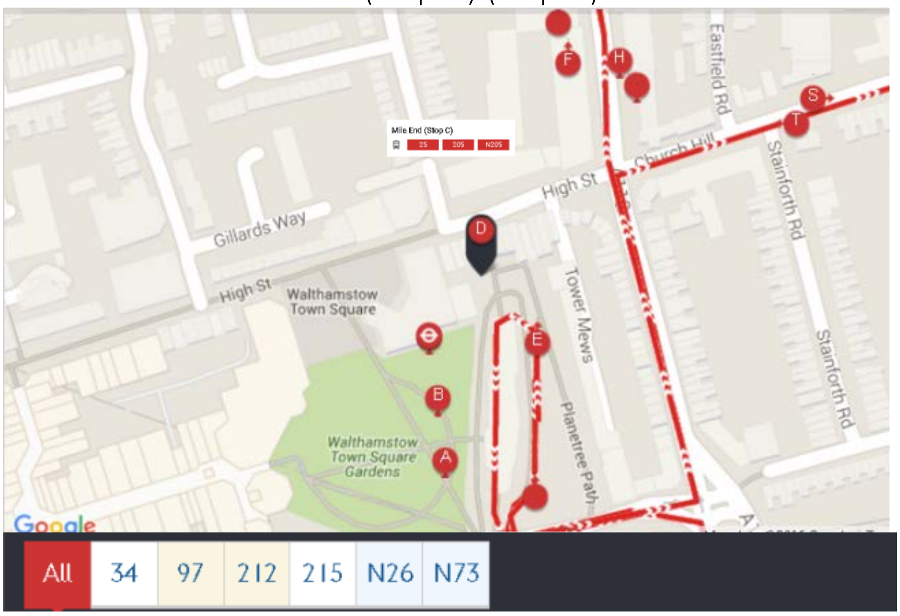
Hammersmith Bus Station (stop C)



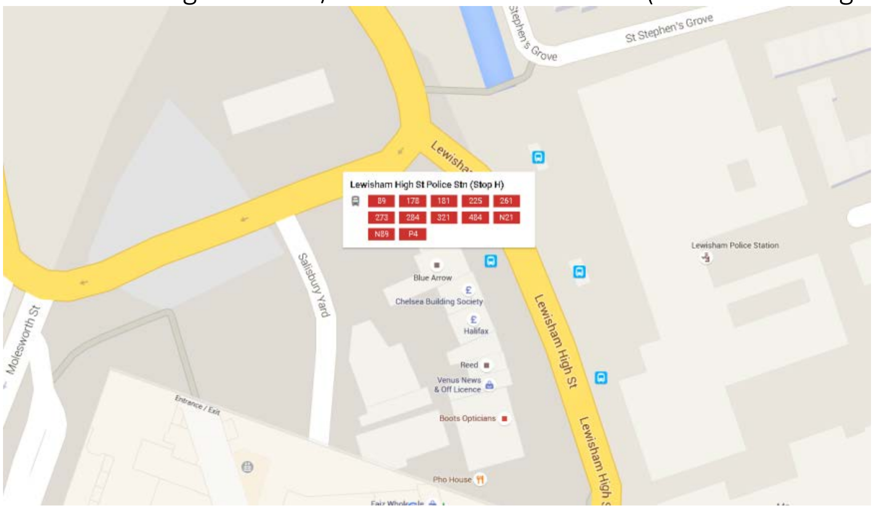
Mile End (Stop A)



Walthamstow Bus Station(stop D) (stop D)



Lewisham High Street / Rennell Street Street (Lewisham High St Police Stn (Stop H))



Bus users were approached using a random 1 in n approach at bus stops. High visibility jackets were worn.

A few scoping questions were asked to ensure that the sample quotas can be met.

If in scope, participants were invited to undertake a follow-up survey on-line or by phone. If yes, we collected their contact details (name and telephone number for follow-up telephone interview and name and e-mail address for follow-up on-line survey).

Interviewers recorded refusals, out of scopes and the number of interviews achieved for each hour period during their shift. They also recorded any comments about factors which might affect the fieldwork.

Overall, the four interviewers undertook 164 interviews with in scope passengers of which 134 gave email addresses and 30 phone numbers for a follow up interview.

Customised emails with a link to the online questionnaire were automatically sent from the tablets at the end of the shift.

Nine of the emails bounced, because of incorrect email addresses. Of the remaining 125, 39 have completed and 10 entered but did not complete. This represents a response rate of 29% on emails collected.

The 30 phone numbers were loaded on to our telephone unit server and so far 3 interviews have been undertaken.

At Stop Recruitment questionnaire data

The number of recruitment interviews by location was:

- Hammersmith Bus Station 39
- Mile End Station 47
- Walthamstow Bus Station 39
- Lewisham High Street / Rennell Street 39

Base 164

Three of the stops had Countdown:

- Yes 76%
- No 24%

Base 164

Forty four per cent walked all the way to the bus stop:

- Walk all way 44%
- Other 56%

Base: 164

Four fifths at Countdown stops had looked at the Countdown sign to check their bus arrival time.

- Yes 80%
- No 20%

Base: 125 at Countdown stops

About half used or were planning to use an app, a website or SMS to check the bus arrival time:

- Yes 49%
- No 51%

Base: 164

There was a minimum quota of 40% for commuting based on the Bus User survey. The main journey purpose for the sample was:

- Commuting 58%
- Business 12%
- Other 31%

Base: 164

There were age quotas as follows, based on the Bus User survey: under29 min 20%, 30-49 min 25%, 50+ min 15%. The age group profile met these quotas:

- 17-20 22%
- 21-29 29%
- 30-39 18%
- 40-49 15%
- 50-59 12%
- 60-69 4%
- 70+ 1%

Base: 164

There was a gender quota of minimum 40% males:

Gender

- Male 42%
- Female 58%

Base: 164

Overall, there were no issues with the administration of the survey or with the questionnaire.

On line sample recruitment questions

20,000 invites were sent rather than 2,000 so the response was much higher than planned. We show the top lines from the first 319 responses.

- Last time caught bus in London
  - Today 47%
  - Yesterday 25%
  - 2-3 days ago 18%
  - 4-5 days ago 6%
  - 6-7 days ago 2%
  - 8-14 days ago 3%

Base: 319

- Did you make both an outward and a return bus trip?
  - Yes, one outward and return bus trip 48%
  - Yes, more than one outward and return bus trip 14%
  - No, just a single leg bus trip 38%

Base: 319

- What was your main journey purpose of this bus journey?
  - Commuting 66%
  - Business 8%
  - Other 27%

Base: 319

Note that a detailed purpose question is in the main part of the questionnaire. We can use this to manage purpose quotas if required.

- How did you travel to the bus stop?
  - Walk all way 84%
  - Other 16%

Base: 319

Main Questionnaire Top Lines

- Leg of journey
  - Outward 18%
  - Return 77%
  - Single journey only 5%

Bases: 39

The Oystercard sample who made return trips were randomly allocated a leg: 34% outward, 28% return.

- Where did the journey start?

	At stop	Oystercard
– Home	33%	59%
– School/college/university	10%	3%
– Normal workplace	26%	17%
– Other workplace/meeting	13%	3%
– Shops/shopping centre	10%	3%
– Restaurant/café/bar	0%	3%
– Home of friends or relatives	3%	2%
– Sport or entertainment location (eg cinema)	3%	4%
– Personal business location (eg hospital, bank)	0%	1%
– Other (please type in)	3%	5%
Bases:	39	319

- What was the main purpose of your bus journey?

	At stop	Oystercard
– Commuting to/from work	49%	58%
– Commuting to/from place of education	18%	9%
– Employers business	0%	2%
– Shopping	13%	7%
– Visiting friends/relatives	5%	7%
– Sport/entertainment	3%	5%
– Other leisure	8%	8%
– Personal business	5%	5%
Bases:	39	319

- Did you get on the first bus that arrived that went to your destination?

	At stop	Oystercard
– Yes	92%	85%
– No, it was too crowded	5%	12%
– No, it was a longer route than a following bus	0%	2%
– No, other (please type in)	3%	2%
Bases:	39	319

'Other' comments were:

- Because it doesn't go through the route I normally go to
- Got on first bus, but it had a collision with a van and people started shouting so got on next bus instead
- I did not want to take 188 because it terminated at Elephant and Castle or it changed drivers. It wastes my time.
- This is the only bus that takes me to St Thomas' Hospital
- Took too long
- two arrived at once so I got on the second bus

- Did you change buses?

	At stop	Oystercard
– Yes	13%	13%
– No	87%	87%
Bases:	39	319

- How long did you spend travelling on the x [bus number] bus?

For at stop sample: Range between 2 and 60 minutes with a mean of 21 minutes and a median of 30 minutes.

For Oystercard sample: Range between 2 and 60 minutes with a mean of 22 minutes and a median of 10 minutes.

	At stop	Oystercard
• On average, how often do you make this journey?		
– 5 or more times a week	26%	38%
– 3-4 times a week	21%	20%
– 1-2 times a week	26%	22%
– 1-3 times a month	8%	10%
– Less than once a month	13%	10%
– First time	8%	4%
Bases:	39	319

	At stop	Oystercard
• Did you travel alone or with others?		
– Alone	90%	85%
– With others	10%	15%
Bases:	39	319

	At stop	Oystercard
• What form of ticket did you use?		
– Oyster (Pay and Go)	31%	42%
– Oyster (Bus Pass)	18%	9%
– Oyster (Travelcard)	23%	42%
– Contactless payment card	13%	4%
– Mobile payment application	0%	0%
– Paper ticket	8%	1%
– Freedom pass/Concessionary bus pass	8%	2%
– Other (please type in)	0%	1%
Bases:	39	319

	At stop	Oystercard
• What was the weather like?		
• Dry/rain		
– Sunny	26%	24%
– Cloudy and dry	74%	48%
– Light rain	0%	25%
– Heavy rain	0%	3%
• Wind		
– Very windy	3%	11%
– Quite windy	41%	53%
– Still	56%	36%
• Temperature		
– Very cold	13%	21%
– Cold	74%	73%
– Mild	13%	6%
– Hot	0%	0%
– Don't remember	0%	1%
Bases:	39	319

Bus waiting time information

	At stop	Oystercard
• Did you use any of the following to get live bus arrival time information?		
– Smartphone/Tablet app	54%	56%
– Internet site	8%	12%

	At stop	Oystercard
– SMS	0%	1%
– No, none of the above	41%	33%
Bases:	39	319

	At stop	Oystercard
• IF NO, NONE OF THE ABOVE: How did you plan your arrival time to the stop?		
– I didn't, I just turned up	75%	78%
– I know when the bus is due to arrive	25%	17%
– Other (please type in)	0%	6%
Bases (didn't use anything to check times before arrival):	16	107

'Other' comments were:

- Estimate
- it is always a nightmare the 77 bus never comes when it is said on the board
- Time shown at bus stop
- when the train arrived

	At stop	Oystercard
• IF GOT LIVE BUS ARRIVAL TIME INFO: Did you check live bus arrival time information before you got to the bus stop?		
– Yes	70%	63%
– No	30%	37%
Bases: those who got live bus arrival time info	23	215

	At stop	Oystercard
• IF CHECKED LIVE BUS ARRIVAL TIME INFO BEFORE GOT TO THE BUS STOP: Where did you check live bus arrival time information?		
– At home	13%	53%
– At workplace	13%	10%
– At restaurant, café, bar	6%	2%
– On street	50%	47%
– Other (please type in)	25%	8%
Bases: those who checked arrival time info	16	136

'Other' comments were:

- before I left my partner's house
- bus finder app
- My phone
- On my phone
- On previous bus
- On the board in the bus station
- On train
- On train journey
- while arriving to Lewisham DLR station
- whilst driving with my husband

Recommendation
Suggest adding code: 'on train, tram or other bus'

	At stop	Oystercard
• Did checking live bus arrival time information before you got to the bus stop lead you to doing any of the following?		
– Leave later than you would have	22%	30%

	At stop	Oystercard
– Go to a different stop	9%	10%
– Use another bus route	0%	8%
– Use another means of travel	0%	6%
– No	70%	62%
Bases: those who got live bus arrival time info	23	215

	At stop	Oystercard
• How accurate would you say the live bus arrival time information was?		
– Spot on	22%	33%
– 1-2 minutes out	48%	47%
– 3-5 minutes out	22%	13%
– More than 5 minutes out	9%	7%
Bases: those who got live bus arrival time info	23	215

Details of wait at stop

- Before arriving at bus stop, how long did you expect to have to wait for the bus at the stop?

For at stop sample: The range was between 1 and 15 minutes with a mean of 7 minutes and median of 5 minutes.
For Oystercard sample: The range was between 1 and 20 minutes with a mean of 5 minutes and median of 5 minutes

	At stop	Oystercard
• Did the stop have a Countdown sign?		
– Yes	38%	42%
– No	62%	58%
Bases:	39	319

Nine passengers who were at stops which had a Countdown sign said the stop did not have Countdown.

87% of the at stop sample and 92% of the Oystercard sample who said the stop had Countdown referred to it.

- How long did you wait at the bus stop before your bus arrived?

For at stop sample: The range was between 1 and 34 minutes with a mean of 8 minutes and median of 5 minutes.
For Oystercard sample: The range was between 1 and 20 minutes with a mean of 5 minutes and median of 5 minutes.

Activities at bus stop

	At stop	Oystercard
• You said you waited x minutes for the bus at the bus stop. In that time, which of the following activities did you do:		
– Using tablet (eg to read, browse the internet… .)	10%	5%
– Using Smart phone/Blackberry/phone (eg to browse…)	38%	39%
– Talking on phone	5%	4%
– Reading a book/magazine/newspaper	0%	7%
– Eating/drinking	8%	2%
– Talking to travelling companions/other travelers	13%	11%
– Listening to music	15%	22%
– Planning things	5%	7%

	At stop	Oystercard
– Doing nothing/relaxing	31%	39%
– Other	5%	8%
Bases:	39	319

Recommendation
TfL mentioned immediately before the pilot that they were not sure doing nothing and relaxing should be in the same tick box. We agree and suggest splitting

TfL also asked if we could amalgamate first two options: Using tablet and Using Smart phone/Blackberry/phone. We think that the use of different types of technology is an important issue and it is useful to segregate the two.

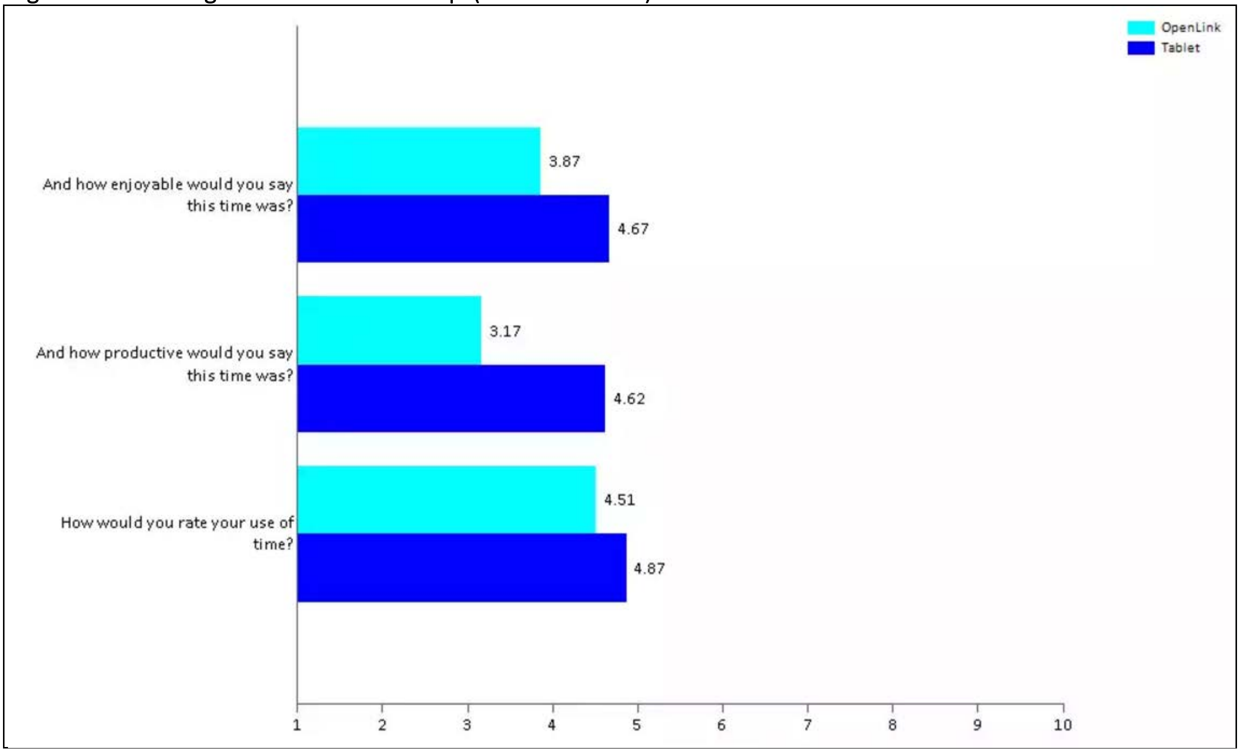
Those that did more than one activity said they spent longest on:	At stop	Oystercard
– Using tablet (eg to read, browse the internet… .)	18%	1%
– Using Smart phone/Blackberry/phone	36%	37%
– Talking on phone	0%	1%
– Reading a book/magazine/newspaper	0%	6%
– Talking to travelling companions/other travelers	0%	8%
– Listening to music	27%	26%
– Planning things	0%	2%
– Doing nothing/relaxing	9%	19%
– Other	9%	1%
Bases: those who did more than one activity	11	105

Passengers were asked to rate the time at the bus stop on the following 11 point scales:

- Use of time
  - 0 – It was a complete waste of time
  - 10 – It was really worthwhile
- how productive would you say this time was
  - 0 – It was completely unproductive
  - 10 – It was very productive
- how enjoyable would you say this time was
  - 0 – It was completely unenjoyable
  - 10 – It was very enjoyable

The mean scores are shown in the table below:

Figure 31: Rating of time at bus stop (mean scores)



Bases: 39 tablet, 319 Oystercard sample

Recommendation
As mentioned by TfL immediately before the pilot, productive and use of time are very similar. We propose omitting 'use of time'.

Activities on bus

- You said that your one way bus journey took x minutes. In that time, which of the following activities did you do:

	At stop	Oystercard
– Using tablet	10%	6%
– Using Smart phone/Blackberry/phone	49%	43%
– Talking on phone	8%	5%
– Reading a book/magazine/newspaper	5%	19%
– Eating/drinking	3%	3%
– Talking to travelling companions/other travelers	10%	13%
– Listening to music	23%	25%
– Doing nothing/relaxing/looking out of window	28%	48%
– Other	3%	2%
Bases:	39	319

Recommendation
TfL mentioned immediately before the pilot that they were not sure doing nothing and relaxing should be in the same tick box. We agree and suggest splitting to 'Doing nothing' and 'Relaxing/looking out of window'

TfL also said that working by reading papers wasn't an option and that perhaps options would be better laid out as:
- Working (papers, on phone, smart phone/tablet)
- Reading/browsing internet (book, smartphone, tablet)
- Eating/drinking

- Listening to music
- Nothing…

We think that the use of technology is an important aspect for this research and therefore we should segregate. Is it important to know if the person is working? We could add 'papers' to 'Reading a book/magazine/newspaper'

Recommendation

'Planning things' was omitted from the on bus activity list. We recommend both lists are the same.

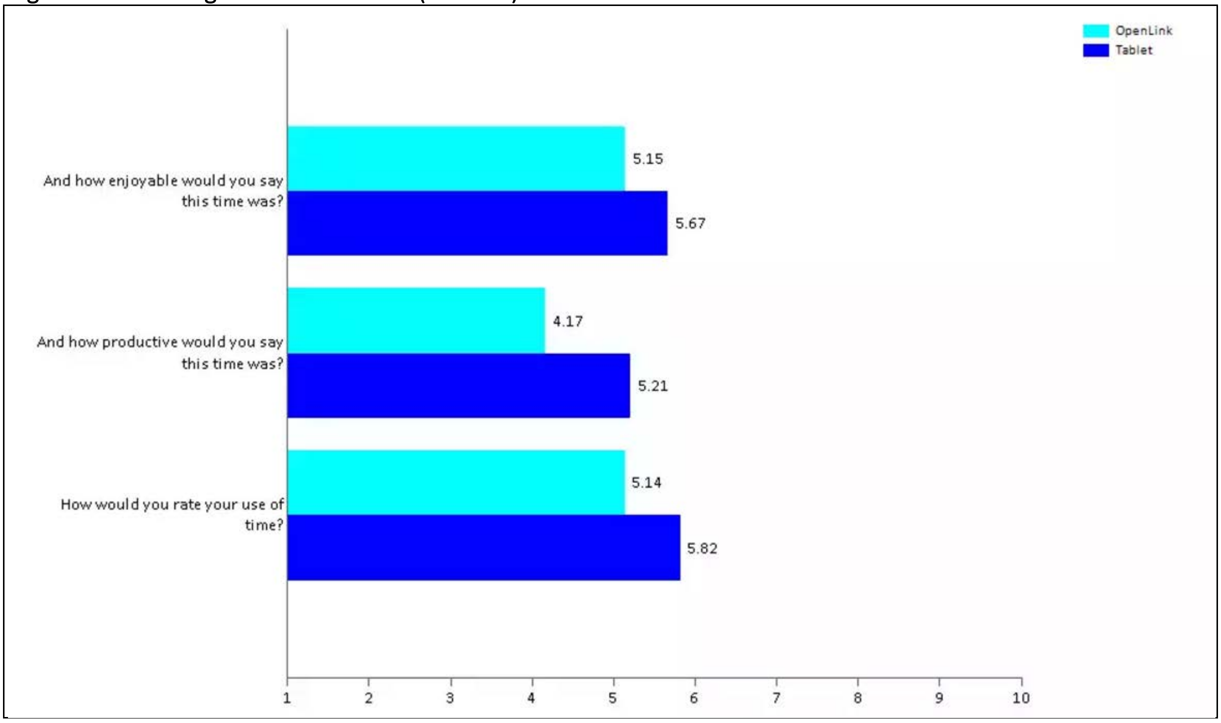
	At stop	Oystercard
For those that did more than one activity they spent longest on:		
– Using tablet	10%	4%
– Using Smart phone/Blackberry/phone	30%	27%
– Talking on phone	10%	0%
– Reading a book/magazine/newspaper	0%	10%
– Eating/drinking	0%	1%
– Talking to travelling companions/other travellers	0%	6%
– Listening to music	30%	28%
– Doing nothing/relaxing	20%	24%
– Other	9%	0%
Bases: those who did more than one activity	10	131

Passengers were asked to rate their time on the bus on the following 11 point scales:

- Use of time
  - 0 – It was a complete waste of time
  - 10 – It was really worthwhile
- how productive would you say this time was
  - 0 – It was completely unproductive
  - 10 – It was very productive
- how enjoyable would you say this time was
  - 0 – It was completely unenjoyable
  - 10 – It was very enjoyable

The mean scores are shown below:

Figure 32: Rating of time on bus (means)



Bases: 39 tablet, 319 Oystercard sample

Recommendation

As mentioned by TfL immediately before the pilot, productive and use of time are very similar. We propose omitting 'use of time'.

- When you boarded the bus, how crowded was it?

	At stop	Oystercard
– Plenty of seats free and did not have to sit next to anyone	44%	35%
– A few seats free but had to sit next to someone. No one standing	18%	14%
– Could sit with people travelling with me	5%	12%
– Could not sit with people travelling with me	0%	1%
– A few seats free but had to sit next to someone. Some people were standing	23%	21%
– A few seats free but could not sit with people travelling with me. No one standing	0%	0%
– A few seats free but could not sit with people travelling with me. Some people were standing	3%	0%
– No seats free – a few others standing	0%	5%
– No seats free – densely packed	8%	11%
Bases:	39	319

- As the journey progressed, did the crowding level change?

	At stop	Oystercard
– It hardly changed	18%	24%
– It got a little more crowded	36%	32%
– It got a lot more crowded	26%	22%
– It got a little less crowded	13%	18%
– It got a lot less crowded	8%	5%
Bases:	39	319

At stop Oystercard

• Did you stand for any part of your bus journey?		
– Yes, all of it	3%	16%
– Yes, about three quarters of it	0%	2%
– Yes, about half of it	3%	2%
– Yes, about a quarter of it	3%	6%
– No, none of it	92%	73%
Bases:	39	319

Classification Questions

	At stop	Oystercard
• In which of the following age categories are you in?		
– 17-20	13%	3%
– 21-29	38%	24%
– 30-39	18%	28%
– 40-49	21%	22%
– 50-59	0%	20%
– 60-69	10%	2%
– 70+	0%	0%
Bases:	39	319

	At stop	Oystercard
• What is your gender?		
– Male	38%	40%
– Female	62%	59%
– Other	0%	1%
Bases:	39	319

Recommendation
We agree with TfL recommendation immediately before the pilot of removing other

	At stop	Oystercard
• What is your employment status?		
– Full time paid employment	38%	63%
– Part time paid employment	23%	8%
– Full time self-employment	8%	9%
– Part time self-employment	3%	2%
– Student	18%	9%
– Waiting to take up a job	0%	1%
– Unemployed	5%	2%
– Unable to work	0%	1%
– Retired	5%	2%
– Looking after home/family	0%	2%
– Other	0%	2%
Bases:	39	319

	At stop	Oystercard
• Gross annual income, before deductions for tax and National Insurance, for your household?		
– Under £10K	5%	6%
– £10-20K	13%	6%
– £20-30K	21%	13%
– £30-40K	8%	14%

– £40-50K	8%	7%
– £50-75K	3%	16%
– £75-100K	3%	9%
– More than £100K	13%	12%
– Don't know	18%	6%
– Refusal	10%	11%
Bases:	39	319

Recommendation
We agree with TfL recommendation immediately before the pilot of changing refusal to prefer not to say

	At stop	Oystercard
• To which of these ethnic groups do you consider you belong?		
A: WHITE		
– British	54%	47%
– Irish	3%	2%
– Any other White background	23%	24%
B: MIXED		
– White and Black Caribbean	0%	1%
– White and Black African	0%	1%
– White and Asian	0%	1%
– Any other Mixed background	0%	3%
C: ASIAN OR ASIAN BRITISH		
– Indian	5%	3%
– Pakistani	3%	1%
– Bangladeshi	0%	0%
– Any other Asian background	0%	1%
D: BLACK OR BLACK BRITISH		
– Caribbean	8%	3%
– African	0%	1%
– Any other Black background	0%	1%
E: CHINESE OR OTHER ETHNIC GROUP		
– Chinese	3%	3%
– Any other ethnic group	3%	1%
– Decline to answer	0%	5%
Bases:	39	319

Recommendation
We agree with TfL recommendation immediately before the pilot of changing decline to answer to prefer not to say

TfL Value of time for bus passengers pilot survey stated preference analysis

Introduction

This note provides an overview of the pilot survey analysis to assess the performance of the stated preference (SP) choice experiment design. The decisions examined through this study are the impact of live bus arrival information on passengers' perceived waiting times to ensure the continued accuracy of the multiplier and the process itself. This note should be read alongside the Accent pilot survey report which provides additional documentation on the execution of the pilot.

Summary of the pilot survey analysis

The pilot survey was undertaken between 26th February and 3rd March with responses from 269 participants being entered in this analysis. Table 5 presents the sample distribution by whether the participants access the live bus information and whether there is a countdown sign at the bus stop. It can be observed that the sampling approaches being used result in good coverage across all four segments, which is desirable in terms of identifying the extent to which the values of waiting time may vary between these.

Table 5 Participants distribution for the pilot survey

	Stop with countdown	Stop without countdown	Total
Accessed live information	22%	41%	63%
Did not access live information	21%	16%	37%
Total	43%	57%	100%

Base: 269

Table 6 presents the percentile of participants who have access to live bus information within each age band. Young people are more likely to access the live bus information compared to the older group of participants. For instance, for participants in the age group of 17 to 20, 92% use live bus information compared to only 8% who do not. The trend is reversed for the older generation. This may associate to that young people are more likely to own and use a smart phone compared to the older generation.

For the main survey, we suggest including a question about the ownership of smartphones. This will allow us to separate the propensity of ownership and the extent to which they are utilised for accessing live bus information.

Table 6: Cross-tabulation of age bands and if participants have access to live bus information

Age group	Accessed live bus information	Did not access live information	Total
17-20	92%	8%	100%
21-29	78%	22%	100%
30-39	61%	39%	100%
40-49	55%	45%	100%
50-59	49%	51%	100%
60-69	33%	67%	100%
70+	100%	0%	100%

Base: 269

Table 7 shows that participants who have access to live bus information have a slightly shorter expected waiting time at 4.59 minutes per journey compared to 5.69 minutes for people who do not. This is consistent to the findings about passengers likely behaviour change when they have access the live bus information. For example, of the 169 participants who have access to live bus information, 27% of them stated they would leave later to reduce their waiting time at the bus stop.

It is also noted that most of the participants (81% of all participants) in the survey stated relatively short expected waiting time (less than 5 minutes). In the main survey, we will retrieve the bus frequency information from the bus number provided by participants to have better understanding of and controlling for the impact of bus frequency on participants' expected waiting time in the analysis.

Table 7: Cross-tabulation of if participants have access to live bus information and expected waiting time

	Have access to live bus information	Not access to live bus information	Have access to live bus information	Not access to live bus information
Expected waiting time	(number of participants)		(column %)	
1-5 mins	146	72	86%	72%
6 - 15 mins	22	27	13%	27%
>15 mins	1	1	1%	1%
Total	169	100	100%	100%
Average expected waiting time (mins/journey)	4.59	5.69		

Base: 269

Participants' trading behaviour

In the SP exercise participants were presented with eight choice scenarios. Each scenario is described by three alternatives. Two of them are unlabelled (named journey A and journey B) journeys and the third option of "not travel by bus". Prior to development of the choice models, we looked at the trading behaviour within the experiment. The trading behaviour refers to if participants appear to have compared the level of attributes and then made the choice rather than always selected the same alternative (for instance, always selected the "journey A" option no matter what the levels of attributes it presented) in the choice. Trading behaviour is essential to a robust estimation of journey and waiting time coefficients.

From the responses to these scenarios, we analysed whether participants' choices were sensitive to the changes of the time attributes. We could not find any non-trading behaviour. 3 out of 269 participants always selected "not travel by bus" across the eight SP choices in their survey. However, we judge that this is sensible as this option could be their true preference under the choice scenarios they were presented. Therefore, these responses are kept in the data analysis.

Diagnostic questions

Following the SP experiment, a series of diagnostic questions were asked to explore participants' understanding of the choice experiment and their perception of the realism of the choices.

Over 93% of the participants stated that they could understand the SP choices. 91% of the participants think the SP choices are easy or moderately easy to make.

The majority of participants demonstrate an understanding of the SP experiment. Therefore, we consider to keep the format and introduction of the SP experiment in the main survey.

Discrete choice model results

The data from the pilot survey was used to estimate some preliminary discrete choice models. As the focus of this analysis is on ascertaining whether the survey is working as intended, the models presented at this stage are relatively simple and do not include consideration of how the preferences and choice may differ between groups of participants by their journey characteristics and socio-economic factors.

The SP choice data are pooled from all of the participants and a single model is estimated. To ensure that the differences in responses are appropriately accounted across sub-segments (for instance, different recruiting methods and journey length), scale parameters are introduced (Daly and Bradley, 1994). This approach best utilises all the choice data available. The scale captures the error (variance) in the responses relative to the reference dataset (for example, bus stop recruiting method).

In reporting the models we present a number of model fit statistics, as described in Table 8.

Table 8: Model fit statistics

Statistic	Definition
Observations	The number of observations included in the model estimation.
Final log (L)	This indicates the value of the log-likelihood at convergence. The log-likelihood is defined as the sum of the log of the probabilities of the chosen alternatives, and is the function that is maximised in model estimation. The value of log-likelihood for a single model has no obvious meaning; however, comparing the log-likelihood of two models estimated on the same data allows the statistical significance of new model coefficients to be assessed properly through the Likelihood Ratio test.
D.O.F.	Degrees of freedom, i.e. the number of coefficients estimated in this model. Note that if a coefficient is fixed to zero then it is not a degree of freedom.
$Rho^2(0)$	The rho-squared measure compares the log-likelihood (LL(final)) to the log-likelihood of a model with all coefficients restricted to zero (LL(0)): $Rho^2(0) = 1 - LL(final)/LL(0)$ A higher value indicates a better fitting model.
$Rho^2(c)$	If we compare the log-likelihood (LL(final)) value obtained with the log-likelihood of a model with only constants (LL(c)) we get: $Rho^2(c): 1 - LL(final)/LL(c)$ Again a higher value indicates a better fitting model.

In interpreting the coefficient values the following points should be considered.

- **A positive coefficient** means that the variable level or constant has a positive impact of utility and so reflects a higher probability of choosing the alternatives to which it is applied.

- **A negative coefficient** means that the variable level or constant has a negative impact on utility and so reflects a lower probability of choosing the alternative to which it is applied.

- **The time coefficients are multiplied by continuous variables** and therefore reflect the disutility per unit change in the expected waiting and journey time.

- **The constants in the model** reflect preferences for the alternatives to which they are applied. Constants are applied to the "not travel by bus" option.

- **A *positive* value for a constant** indicates that the participant is *more likely* to choose that alternative, and a ***negative* value** indicates that the participant is *less likely* to choose that alternative.

- As the **scale parameters** are inversely related to the error variance of each dataset, for a given set of scales, a scale parameter smaller than one (reference) indicates that the dataset has a greater level of the error variance compared to the reference dataset.

- Both the resulting coefficients and their t-ratios are provided. The t-ratios define the (statistical) significance of the coefficient estimate; regardless of the sign, the larger the t-ratio, the more significant the estimate. A coefficient with a t-ratio greater than +/-1.960 is estimated to be significantly different from zero at the 95% confidence level. A t-ratio of +/-1.645 is significantly different from zero at the 90% confidence interval. We generally seek to estimate coefficients that exceed the 95% confidence interval, although this is not always possible with the amount of data available at this stage.

We have tested a series of model structure and present the preferred model so far in Table 9.

Table 9: Pilot model estimation

Summary statistics	
Observations	2152
Final Log Likelihood	-1709.6
D.O.F	11
Rho²(0)	0.277
Rho²(c)	0.134

Variables	Estimate	t-ratio
Journey time coefficients		
Expected Journey Time	-0.0820	-4.7
Expected Waiting time	-0.1682	-4.5
Constants - Not travel by bus options		
Not travel - long journey length online recruitment	-6.3989	-4.8
Not travel - long journey length bus stop recruitment	-6.6079	-5.1
Not travel - medium journey length online recruitment	-4.1110	-4.5
Not travel - medium journey length bus stop recruitment	-5.0575	-5.2
Not travel - short journey length online recruitment	-2.2085	-4.5
Not travel - short journey length bus stop recruitment	-2.6097	-4.9
Model structure coefficients		
scale parameter for online recruitment	1.6653	5.4
scale parameter for bus stop recruitment (ref)	1.0000	n/a
scale parameter for long journey length (ref)	1.0000	n/a
scale parameter for medium journey length	1.0077	6.5
scale parameter for short journey length	1.4973	6.6

The model results look encouraging:

- At this stage we have only estimated a simple model with the generic expected journey time and waiting time. In the main stage survey, we will test different model specification and consider the impacts of other factors (such as access of live bus information) on the time coefficients estimation.

- Both time coefficients are strongly estimated with a correct sign (negative), indicating that with all the other conditions being equal, participants prefer to have a lower waiting and lower journey time.

- The multiplier between the expected waiting time and journey time is 2.05, which is within the range that we might expect (although lower than the current Webtag recommended value of 2.5).

- The constants on the "Not travel by bus" terms are significantly negatively estimated for each journey length group by different recruitment method. This indicates that participants are less likely to select this option compared to the options of making bus journeys.

- In terms of scale parameter, compared to the bus stop recruitment method, the responses recruited from online sample show less noise (greater scale parameter). Compared to the responses from those making longer journeys, the responses from those making shorter journeys group show less noise.

Conclusion and recommendation

The pilot survey analysis shows that the survey and choice experiments are working as intended.

The expecting waiting time is slightly shorter for the participants who stated that they have access to the live bus information. It is noted that most of the participants from the pilot survey have a relatively short expected waiting time (less than 5 minutes).

The choice data collected through the pilot suggests that participants are able to understand the choice experiments and making their choices by considering the levels of attributes and doing trade-off.

The preliminary model estimation looks encouraging and some intuitive findings are emerging, which also provides a reassurance that the participants are responding in rational ways.

On the basis of this pilot analysis we would recommend taking forward this design to the main survey. From this we will have a much larger data set that will allow us to test a range of model specifications and gain insight into how accessing the bus live information affect participants' perceived value of waiting and in vehicle time.

We proposed a couple recommendations for the main survey:

- Include a question on the ownership of smartphones to allow a distinction between the ownership of these devices and their use for accessing live bus information.

- Retrieve the bus frequency information to allow a fuller analysis of the impact of bus frequency on participants' expected waiting time.

APPENDIX E

Weighting Procedures

Target weights

The Bus User Survey has different age bands and purpose categories to those used in this survey. The process for calculating the target weights is shown below.

Age

Since the Bus User Survey uses different age bands from the ones used in this survey we converted the Bus User Survey age ranges as follows:

<table>
<tr><th rowspan="2">Bus User survey Age range</th><th rowspan="2">Converted age ranges</th><th rowspan="2">n</th><th rowspan="2">Target age range</th><th colspan="2">Bus user survey</th><th rowspan="2">VoT %</th><th rowspan="2">Weights</th></tr>
<tr><th>n</th><th>%</th></tr>
<tr><td>16-17</td><td>17 (1)</td><td>1121.5</td><td rowspan="3">17-20</td><td rowspan="3">4835.5</td><td rowspan="3">10.3</td><td rowspan="3">6.2</td><td rowspan="3">1.66129</td></tr>
<tr><td>18-19</td><td>18-19</td><td>2331</td></tr>
<tr><td rowspan="2">20-24</td><td>20 (2)</td><td>1383</td></tr>
<tr><td>21-24 (3)</td><td>5532</td><td rowspan="2">21-29</td><td rowspan="2">12440.5</td><td rowspan="2">26.5</td><td rowspan="2">20.8</td><td rowspan="2">1.27404</td></tr>
<tr><td rowspan="2">25-34</td><td>25-29 (4)</td><td>6908.5</td></tr>
<tr><td>30-34 (4)</td><td>6908.5</td><td rowspan="2">30-39</td><td rowspan="2">11348.5</td><td rowspan="2">24.1</td><td rowspan="2">28.4</td><td rowspan="2">0.84859</td></tr>
<tr><td rowspan="2">35-44</td><td>35-39 (5)</td><td>4440</td></tr>
<tr><td>40-44 (5)</td><td>4440</td><td rowspan="2">40-49</td><td rowspan="2">7627</td><td rowspan="2">16.2</td><td rowspan="2">21.3</td><td rowspan="2">0.76056</td></tr>
<tr><td rowspan="2">45-54</td><td>45-49 (6)</td><td>3187</td></tr>
<tr><td>50-54 (6)</td><td>3187</td><td rowspan="2">50-59</td><td rowspan="2">5297</td><td rowspan="2">11.3</td><td rowspan="2">16.9</td><td rowspan="2">0.66864</td></tr>
<tr><td>55-59</td><td>55-59</td><td>2110</td></tr>
<tr><td>60-64</td><td>60-64</td><td>1871</td><td rowspan="2">60-69</td><td rowspan="2">3312</td><td rowspan="2">7.0</td><td rowspan="2">4.6</td><td rowspan="2">1.52174</td></tr>
<tr><td>65-69</td><td>65-69</td><td>1441</td></tr>
<tr><td>70-79</td><td>70-79</td><td>1531</td><td rowspan="2">70+</td><td rowspan="2">2172</td><td rowspan="2">4.6</td><td rowspan="2">1.9</td><td rowspan="2">2.42105</td></tr>
<tr><td>80+</td><td>80+</td><td>641</td></tr>
<tr><td>Totals</td><td></td><td>47032.5</td><td></td><td>47032.5</td><td>100</td><td>100</td><td></td></tr>
</table>

Notes: (1) 50% of 16-17, (2) 20% of 20-24, (3) 80% of 20-24, (4) 50% of 25-34, (5) 50% of 35-44, (6) 50% of 45-54

Purpose

Because the Bus User Survey uses some different purpose categories from the ones used in this survey we converted the purpose categories as follows:

<table>
<tr><th rowspan="2">Bus User survey purpose categories</th><th rowspan="2">n</th><th rowspan="2">Target purpose categories</th><th colspan="2">Bus user survey</th><th rowspan="2">VoT %</th><th rowspan="2">Weights</th></tr>
<tr><th>n</th><th>%</th></tr>
<tr><td>Travelling to/from work</td><td>23990</td><td>Travelling to/from work</td><td>23990</td><td>52.0</td><td>50.2</td><td>1.03586</td></tr>
<tr><td>To/from school/education</td><td>3068</td><td>To/from school/education</td><td>3068</td><td>6.7</td><td>7.7</td><td>0.87013</td></tr>
<tr><td>Employer Business</td><td>863</td><td>Employer Business</td><td>863</td><td>1.9</td><td>2.8</td><td>0.67857</td></tr>
<tr><td>To/from shopping</td><td>4218</td><td>To/from shopping</td><td>4218</td><td>9.1</td><td>9.9</td><td>0.91919</td></tr>
<tr><td>Visiting friends/relatives</td><td>4392</td><td>Visiting friends/relatives</td><td>4392</td><td>9.5</td><td>7.3</td><td>1.30137</td></tr>
<tr><td>Healthcare Appointment</td><td>974</td><td rowspan="5">Personal business</td><td rowspan="5">4405</td><td rowspan="5">9.6</td><td rowspan="5">10.1</td><td rowspan="5">0.95050</td></tr>
<tr><td>Personal Business</td><td>980</td></tr>
<tr><td>Picking up/dropping off someone</td><td>267</td></tr>
<tr><td>Taking/collecting child</td><td>420</td></tr>
<tr><td>Other</td><td>1764</td></tr>
<tr><td>Holiday/Sightseeing</td><td>941</td><td rowspan="2">Leisure (1)</td><td rowspan="2">5198</td><td rowspan="2">11.3</td><td rowspan="2">11.9</td><td rowspan="2">0.94958</td></tr>
<tr><td>Leisure</td><td>4257</td></tr>
<tr><td>Totals</td><td>46134</td><td></td><td>46134</td><td>100</td><td>100</td><td></td></tr>
</table>

Notes: (1) combines 'sport/entertainment' and 'other lesiure' from VoT survey

Gender

	Bus user survey (targets) %	VoT %	Weights
Male	42.8	35.3	1.21246
Female	57.2	64.7	0.88408
Totals	100	100	

APPENDIX F

Stated Preference experiment design

Stated Preference experiment design

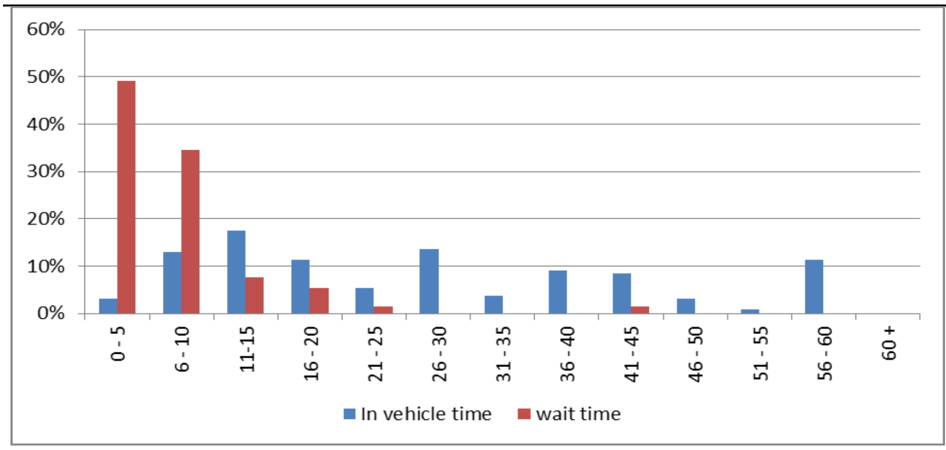
Defining the levels of SP attributes

Participants were asked about the journey characteristics of their most recent journey or the journey they made when they were interviewed at the bus stop. The levels of attributes were tailored to each participant's stated expected waiting and journey time from the background questions to increase the realism of the choice experiment. The levels were defined as percentage differences around the current times. This avoided the potential problem of negative journey time or waiting times. Whilst calculated as percentage changes, in the choices, the attributes were presented as absolute values, e.g. expected waiting time 10 minutes.

One of the challenges of using percentage changes is that these can lead to very large changes on longer journeys or those with longer waiting times. To avoid this, three different bands were used to define the percentage changes to apply to each of the attributes. The thresholds to use for these bands were determined by analysing current bus users from the value of time survey sample (2015) from London which include 132 participants.

Figure 33 presents the distribution of the waiting and in-vehicle time for the London bus users in the value of time study (2015).

Figure 33 Distribution of stated waiting and in-vehicle times (minutes) of London bus users



Source: Value of time study sample from London (132 participants)

Based on the waiting and journey time distribution, 5 minutes and 15 minutes are set as the threshold for the low and high time bands for participants expected waiting time attribute; 10 and 30 minutes as the threshold for expected in-vehicle time attribute as shown in Table 10.

Table 10 Thresholds for the time attributes bands in SP design

	Expected waiting time (mins)	Expected in-vehicle time (mins)
Low	<=5	<= 10
Medium	6 – 15	11 – 30
High	>= 16	>=31

Within each of these journey waiting time bands, nine different percentage levels (including the current level) were tested to ensure a large range of values in the choice experiments.

The levels for each attribute are presented in Table 11 for each time band. For the short journey length band, we proposed to apply relatively higher percentage adjustments (up to 80% change) compared to the longer journey length band (up to 40% change). This is to ensure that the absolute time differences varied across a sufficient range for the relatively short journey band.

Table 11: Attribute levels (in percentage) for each band in the SP design

	Low		Medium		High	
Level	Waiting time	In-vehicle time	Waiting time	In-vehicle time	Waiting time	In-vehicle time
1	20%	20%	50%	50%	60%	60%
2	40%	40%	70%	70%	80%	80%
3	60%	60%	80%	80%	90%	90%
4	85%	85%	90%	90%	95%	95%
5	100%	100%	100%	100%	100%	100%
6	115%	115%	110%	110%	105%	105%
7	140%	140%	120%	120%	110%	110%
8	160%	160%	130%	130%	120%	120%
9	180%	180%	150%	150%	140%	140%

Combination of the levels of attributes

A fractional factorial orthogonal plan was used to specify the combinations of attributes and levels to be presented in the choice experiment scenarios. This gave a total of 16 choice scenarios in total. Each participant was presented with 8 scenarios, and these were assigned using orthogonal blocking to ensure that each set of scenarios was balanced across levels. The design was generated using SPSS software using an approach which allowed us to ensure that:

- The design was able to recover a wide range of the waiting time to in-vehicle time multiplier.
- The levels for the attributes were balanced and distributed approximately equally between values better and worse than the existing values.
- There were no dominant alternatives (i.e. we presented no cases where one alternative was preferable for both waiting and journey time attributes).

Appendix G

SP survey sample, bus frequency, calculation of expected waiting time

SP survey sample, bus frequency, calculation of expected waiting time

Characteristics of the survey sample and information provision

Table 12 presents the sample distribution according to whether the participants accessed live bus information and whether there was a countdown sign at the bus stop. The sampling approaches used resulted in good coverage across all the information segments, which is desirable in terms of identifying the extent to which the values of waiting time may vary between these.

Table 12 Access to live information and countdown

	Checked information before going to bus stop	With countdown	No countdown	Total
Have access to live bus information	Checked	13%	26%	39%
	Not checked	10%	13%	22%
No access	N/A	21%	18%	38%
Total		43%	57%	100%

Base: 1690

Bus frequency analysis

The bus frequency information was retrieved from the operational details of bus routes in London using participants stated bus number and time travelled. The high frequency services refer to cases where there were 5 or more services per hour (i.e. headway equal or smaller than 12 minutes). Table 13 presents the percentage of participants who have access to live bus information by bus route service frequency. Travellers who were travelling on low frequency routes were more likely to use live bus information and check before going to the bus stop.

Table 13: Access to live information by bus service frequency (column %)

	Checked information before going to bus stop	Bus Frequency High	Low	N/A [10]	Total
Have access to live bus information	Checked	37%	51%	39%	39%
	Not checked	23%	21%	18%	22%
No access	N/A	41%	28%	43%	38%
Total		100%	100%	100%	100%

Based: 1690

Table 14 shows on average there are less countdown information facilities on the low frequency routes (30% versus 70%), compared to the high frequency routes (46% versus 54%).

[10] The N/A group contains those cases where the bus frequency could not be determined.

Table 14: Bus frequency and the countdown information at bus stop (row %)

Bus frequency	with countdown	No countdown	Total
High	46%	54%	100%
Low	30%	70%	100%
N/A	52%	48%	100%
Total	43%	57%	100%

Base: 1690

Table 15 to Table 19 present the cross-tabulation of journey characteristics by service frequency.

Table 15 Journey purpose and bus frequency

Journey purposes	Bus Frequency							
	High	Low	N/A	Total	High	Low	N/A	Total
Commuting to/from work	633	167	66	866	73%	19%	8%	100 %
Commuting to/from place of education	101	24	12	137	74%	18%	9%	100 %
Employers business	40	4	1	45	89%	9%	2%	100 %
Shopping	126	28	7	161	78%	17%	4%	100 %
Visiting friends/relatives	92	19	10	121	76%	16%	8%	100 %
Sport/entertainment	45	19	6	70	64%	27%	9%	100 %
Other leisure	96	27	9	132	73%	20%	7%	100 %
Personal business	118	29	11	158	75%	18%	7%	100 %
Total	1251	317	122	1690	74%	19%	7%	100 %

Table 16 Journey frequency and bus frequency

Journey Frequency	Bus Frequency							
	High	Low	N/A	Total	High	Low	N/A	Total
5 or more times a week	429	124	47	600	72%	21%	8%	100 %
3-4 times a week	205	55	19	279	73%	20%	7%	100 %
1-2 times a week	254	61	16	331	77%	18%	5%	100 %
1-3 times a month	178	42	11	231	77%	18%	5%	100 %
Less than once a month	120	24	10	154	78%	16%	6%	100 %
First time	65	11	19	95	68%	12%	20%	100 %
Total	1251	317	122	1690	74%	19%	7%	100 %

Table 17 Ticket type and bus frequency

Ticket type	Bus Frequency							
	High	Low	N/A	Total	High	Low	N/A	Total
Oyster (Pay and Go)	537	123	37	697	77%	18%	5%	100 %
Oyster (Bus Pass)	132	39	6	177	75%	22%	3%	100 %
Oyster (Travelcard)	426	121	59	606	70%	20%	10%	100 %
Contactless payment card	71	12	10	93	76%	13%	11%	100 %
Mobile payment application (eg Apple Pay etc.)	2	1		3	67%	33%	0%	100 %
Paper ticket (Day Bus Pass etc.)	9	2	4	15	60%	13%	27%	100 %
Freedom pass/Concessionary bus pass	65	17	4	86	76%	20%	5%	100 %
Other (please type in)	9	2	2	13	69%	15%	15%	100 %
Total	1251	317	122	1690	74%	19%	7%	100 %

Table 18 Expected waiting time and bus frequency

Expected waiting time band	Bus Frequency							
	High	Low	N/A	Total	High	Low	N/A	Total
Short (< 5 minutes)	958	218	94	1270	75%	17%	7%	100 %
Med (5 - 10 minutes)	281	90	25	396	71%	23%	6%	100 %
Long (> 10 minutes)	12	9	3	24	50%	38%	13%	100 %
Total	1251	317	122	1690	74%	19%	7%	100 %

Table 19 In-vehicle journey time and bus frequency

Journey time band	Bus Frequency							
	High	Low	N/A	Total	High	Low	N/A	Total
Short (<10 minutes)	379	132	59	570	66%	23%	10%	100 %
Med (10 - 30 minutes)	647	146	43	836	77%	17%	5%	100 %
Long (> 30 minutes)	225	39	20	284	79%	14%	7%	100 %
Total	1251	317	122	1690	74%	19%	7%	100 %

Calculation of the average expected waiting time

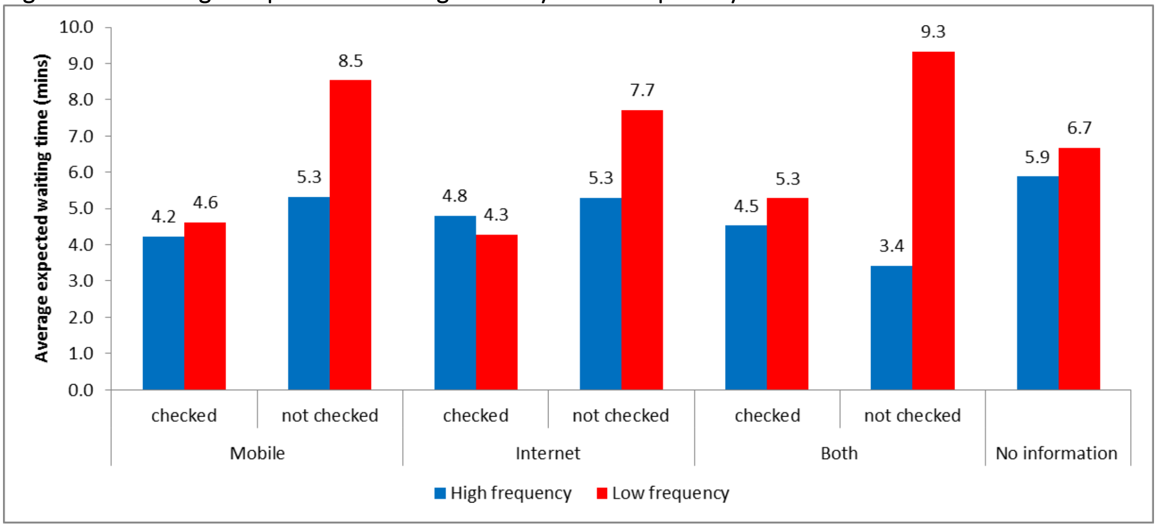
Live bus information provides bus users arrival information before they reach the bus stop. In the survey, participants were asked to recall what they had expected their waiting time to be before arriving at the bus stop. We examined if this information impacted passengers' expected waiting time by comparing the average expected waiting time by different means of checking live bus information as shown in Table 20 and Figure 34.

Table 20 Average expected waiting time by means of checking live bus information and bus frequency

		High frequency	Low frequency	n/a	Total
Mobile	checked	4.2	4.6	3.8	4.3
	not checked	5.3	8.5	5.9	5.9
Internet	checked	4.8	4.3	3.0	4.6
	not checked	5.3	7.7	7.7	5.9
Both	checked	4.5	5.3	1.0	4.6
	not checked	3.4	9.3		4.6
No information		5.9	6.7	5.5	6.0

We find that across all bus information segments, participants on the low frequency routes have a slightly longer expected waiting time compared to those on the high frequency routes, as would be expected without taking account of information provision. However, this difference varies across the different information provision groups.

Figure 34 Average expected waiting time by bus frequency and access to live information



From Table 21 a wider spread (i.e. a large standard deviation) of the expected waiting time can be observed for the low frequency group, especially for the group who have not checked the information prior to their trip, which shows a larger variation of passengers' expected waiting time.

Table 21: Average expected waiting time by bus frequency and access to live information

	High frequency			Low frequency			Diff.
	sample	average	s.d.	sample	average	s.d.	t - value
No apps	507	5.9	3.4	88	6.7	3.7	1.9
Not checked information	287	5.4	3.1	67	8.4	8.4	2.9
Checked information[11]	457	4.3	3.3	162	4.5	4.0	0.5
Totals	**1251**	**5.2**	**3.4**	**317**	**5.9**	**5.4**	**2.3**
t (checked vs not checked)		4.6			3.7		
t (no apps vs. not		1.9			-1.6		

[11] The comparison shows that there is no significant difference in the pattern of expected waiting time by different means of checking live bus information. More details can be found in Appendix B.2.

checked)			

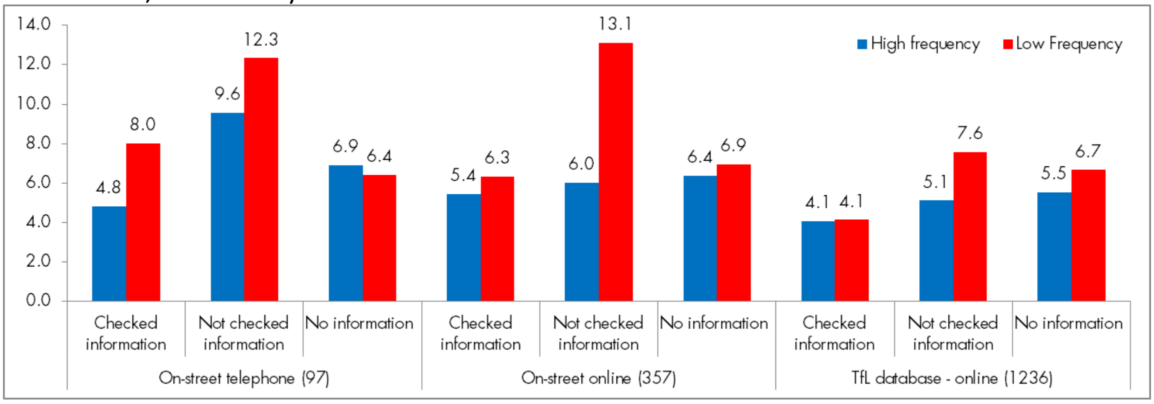
Moreover, the standard deviation for the estimate for those who had access to live information but did not check it is much higher than for the other estimates. We did not find obvious differences in their journey characteristics (journey purpose, frequency, travel time of day etc.) between these two groups of participants which could contribute to the difference in the expected waiting time. Passengers who do not have information were asked in the survey how they planned their arrival time to the bus stop. Around 50% of the participants on the low frequency services stated that they knew either when the bus was due to arrive or the frequency of the bus. Therefore, it is suspected that participants who do not have information have a relatively good knowledge of the bus frequency. In the survey, we did not collect the same information for passengers who had access to live bus information; therefore we cannot do a like-for-like comparison.

We then compare the difference in average expected waiting by survey method. Table 22 and Figure 35 show the comparison with the statistic tests.

Table 22 Average expected waiting time by means of checking live bus information, bus frequency and survey method

		High frequency			Low Frequency		
		sample	mean	s.d	sample	mean	s.d
On-street telephone (97)	Checked information	10	4.8	1.9	4	8.0	4.0
	Not checked information	7	9.6	5.2	3	12.3	6.8
	No information	52	6.9	3.9	12	6.4	4.5
On-street online (357)	Checked information	86	5.4	4.0	21	6.3	5.4
	Not checked information	66	6.0	3.4	8	13.1	7.5
	No information	128	6.4	3.1	15	6.9	4.4
TfL database - online (1236)	Checked information	361	4.1	3.3	137	4.1	3.2
	Not checked information	214	5.1	2.8	56	7.6	8.5
	No information	327	5.5	3.2	61	6.7	3.9
t (On-street telephone vs TfL)	Checked information		1.20			1.92	
	Not checked information		2.25			1.16	
	No information		2.43			-0.17	
t (On-street online vs TfL)	Checked information		2.98			1.84	
	Not checked information		1.96			1.92	
	No information		2.57			0.22	
t (On-street tele. vs on-street online)	Checked information		-0.86			0.72	
	Not checked information		1.77			-0.17	
	No information		0.90			-0.30	

Figure 35 Average expected waiting time by bus frequency and access to live information, and survey method



This follows the same pattern as the average value discussed above, though we can observe that the average values from on-street recruited are higher than those recruited from the TfL database, especially for the "not checked information" group. For the not checked information group, the t-statistic tests accepted that the expected waiting time is significantly higher for passengers on high frequency services who were recruited by on-street approach at the 95% confidence interval, whilst for low frequency services, this impact is not significant. We can see that there is no significant difference in expected waiting time between the on-street telephone survey and on-street online survey by different information source bands.

Appendix H

Discrete choice model theory background and model analysis

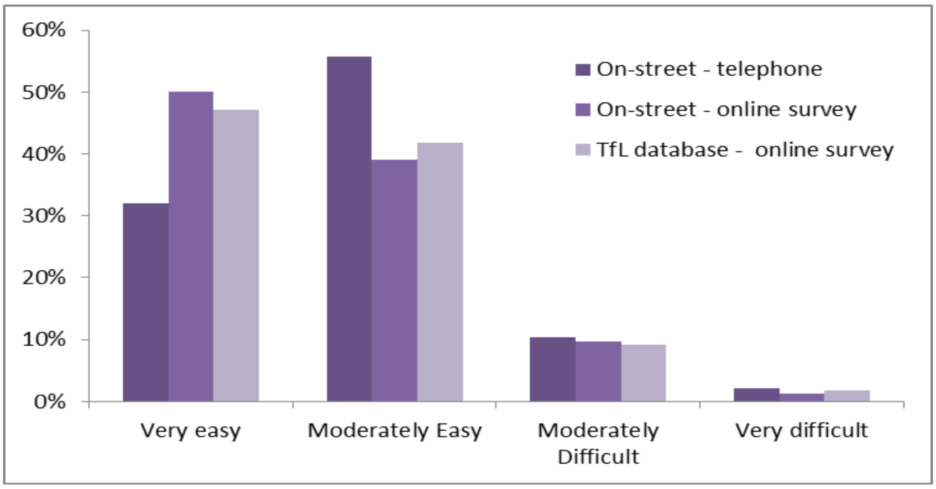
Discrete choice model theory background and model analysis

Responses to diagnostic questions

Prior to developing the discrete choice models, we have examined the responses to a set of diagnostic questions that formed part of the questionnaire to explore participants' understanding of the choice experiment and their perception of the realism of the choices. This provides us a better understanding of the quality of the choice data.

Over 92% of the participants stated that they could understand the SP choices. 89% of the participants thought that the SP choices were easy or moderately easy to make. The perceived difficulty varied by survey recruiting approach as shown in Figure 36.

Figure 36 Participants' perceived difficulty of answering choice questions by recruiting method



Participants who were recruited on-street and participated in telephone interviews felt that the survey was not as easy as those who were recruited on-street and participated in an online survey, or those who were recruited from the TfL user database straight into the online survey. However, the majority of participants were able to understand the SP experiment and make the choices, with only a small percentage finding the choice experiments "very difficult".

Discrete choice model theory

Discrete choice models are used to gain insight into what drives the decisions that individuals make when faced with a number of (discrete) alternatives. These models are constructed by specifying the range of alternatives available to the decision maker, and describing each of these by a utility equation that reflects the attributes and levels of each. Each attribute in the model is multiplied by a coefficient that reflects the size of its impact on the decision making process (Ben-Akiva & Lerman 1985; Train 2003).

It is the model coefficients that are estimated in the model estimation procedure. The model is based on the assumption that each participant chooses the alternative that provides him or her with the highest utility. An error term is included in each utility function to reflect unobservable factors in the individual's utility. The estimation can therefore be conducted within the framework of random utility theory, thus accounting for the fact that the analyst has only imperfect insight into the utility functions of the participants.

The most popular and widely available estimation procedure is logit analysis. This produces estimates of the model coefficients, such that the choices made by the participants are best represented. The standard statistical criterion of Maximum Likelihood is used to define best fit. The model estimation provides both the values of the coefficients (in utility terms) and information on the statistical significance of the coefficients.

Additional terms and non-linear variations can be tested, with the testing of the appropriate forms for the utility functions being an important part of the model estimation process. By examining different segmentation within the models we can investigate whether different groups of participants place different values on the attributes in the choices, and can also test whether there are certain groups of participants that are more likely to systematically choose one alternative over another.

Multinomial Logit (MNL) models (Ben-Akiva & Lerman 1985; Train 2003) have been developed to reflect participants' choice observations in each segment. To ensure that the differences in responses are appropriately accounted across sub-segments, scale parameters are introduced (Daly & Bradley 1991). This approach best utilises all the choice data available.

Table 23 describes the list of terms in the overall model fit statistics and the characteristics of the coefficients.

Table 23: Interpretation of the model fit statistics and coefficient estimations

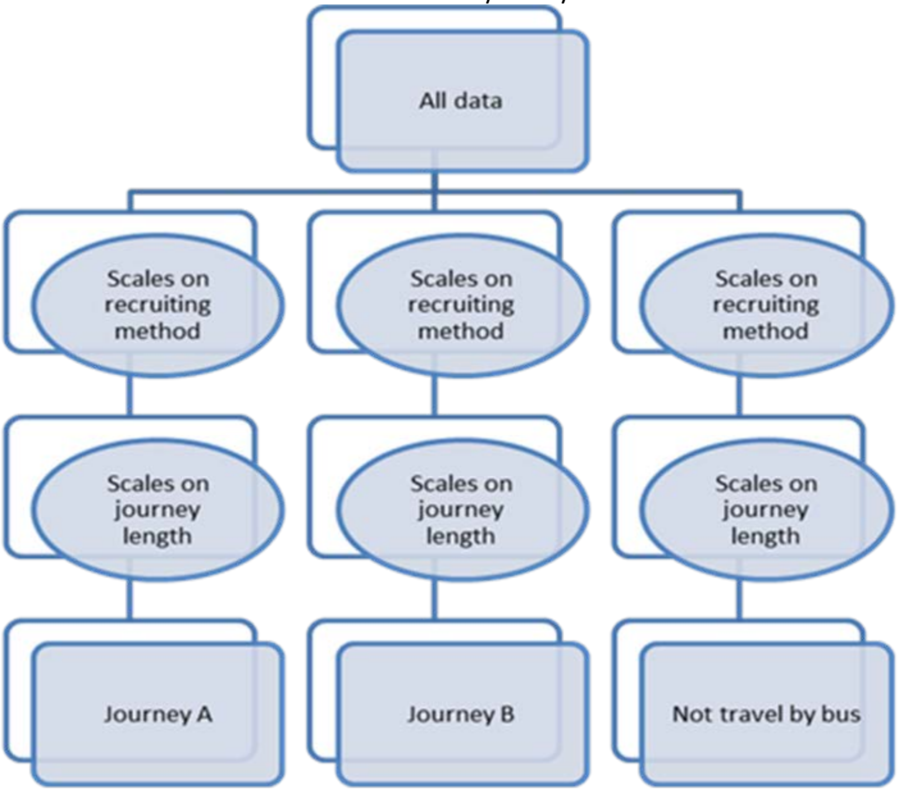
Statistic	Definition
Observations	The number of choice observations included in the model estimation (reflecting the number of participants and number of choice scenarios).
Final log (L)	This indicates the value of the log-likelihood at convergence. The log-likelihood is defined as the sum of the log of the probabilities of the chosen alternatives, and is the function that is maximised in model estimation. The value of log-likelihood for a single model has no obvious meaning; however, comparing the log-likelihood of two models estimated on the same data allows the statistical significance of new model coefficients to be assessed properly through the Likelihood Ratio test.
D.O.F.	Degrees of freedom, i.e. the number of coefficients estimated in this model. Note that if a coefficient is fixed to zero then it is not a degree of freedom.
Rho2(c)	If we compare the log-likelihood (LL(final)) value obtained with the log-likelihood of a model with only constants (LL(c)) we get: Rho2(c): 1 – LL(final)/LL(c) A higher value indicates a better-fitting model.
Interpreting the coefficient estimation	
Sign	The sign of the coefficient indicates the preference for that attribute. A positive sign indicates that the attribute has a positive impact on participants' choices, and therefore the attribute is preferred by participants and vice versa. In the case of attributes with different levels that have been coded as categorical variables in the choice models it indicates the preference for an attribute level relative to its reference level. The base level is a fixed attribute level relative to which the effects of other attribute levels are measured. A positive sign indicates that the attribute level is preferred relative to the base level by participants and vice versa.
Magnitude	The magnitude of the coefficient indicates the degree of preference. The larger the coefficient the stronger the preference for the attribute.
Reference level	In the case of categorical variables it is necessary to fix a coefficient related to one of the levels to zero in order to estimate the model. The coefficients estimated for all other levels in that variable are then estimated with reference to the base level.
t-ratio	This indicates the significance of the coefficient. A 't-ratio' equal to (+/-) 1.96 indicates that the corresponding coefficient is significant at a 95 per cent level and in practice is the minimum acceptable level at which the effect implied by the coefficient is called significant. A 95 per cent significance level indicates that the corresponding effect identified has only 5 per cent chance of being purely random.

Testing the model structure

To pool the data from different sources, scale parameters were incorporated into the choice models to take account of the potential differences in error between the different datasets (in this case by recruiting method and journey length). After several attempts, the preferred modelled structure contains two levels of scales: firstly by recruiting method and second by different journey distance band.

Figure 37 shows the model structure adopted for the main survey analysis. As the scale parameters are inversely related to the error variance of each dataset, a scale parameter smaller than one indicates that the dataset has a greater level of error variance compared to the reference dataset.

Figure 37 Model structure for the main survey analysis



Discrete choice model development

Tests were undertaken to examine the impact of socio-demographic, journey characteristics and other factors on the importance of the time attributes in the stated choices. Table 24 presents the findings from the separate tests. The impact of the tests are summarised by colour codes, illustrating whether the coefficients are positive or negative, relative to the reference level, and the level of significance.

Table 24: Tests on socio-demographic and journey characteristics

Factor	Reference	On expected waiting time	On expected journey time
Bus journey characteristics			
Bus frequency	High frequency	Low frequency & n/a	Low frequency & n/a
Journey purposes	Commute	Other purposes	Other purposes
Journey time	< 10 minutes	med or long journey	med or long journey
Travel frequency	Travelled before / 5 times a week (journey time)	First time	less than 5 times a week and first time
Ticket type	Oyster card (pay and go)	trend is not clear	trend is not clear
Time of day and day of week	AM peak (6:30 - 9:30am)	Other time period and weekends	Other time period and weekends
Group size	along	not significant impact	not significant impact
Weather condition			
Dry	Sunny	Cloudy and dry	
		Light Rain	
		Heavy rain	
Wind	Still	Very windy	
		Quite windy	
Temperature	Very cold	Cold	
		Mild	
		Hot	
Bus arrival information			
Have arrival information apps/tools	no arrival information apps/tools	Have arrival information	
Checked the arrival information	checked the arrival information	not checked	both no and not-checked
Countdown	no countdown	with countdown	
Ways of checking the bus arrival information			
Mobile	have but not checked	checked	checked
Internet	have but not checked	checked	checked
Both	have but not checked	checked	checked
Where did you checked the information			
	not checked or no access to information	On street and other	at home, on street, other
		at home, restaurant, workspace	at restaurant
		on train, tram and other bus	on train, tram and other bus
Socio - demographic features			
Age	(17 - 20)	21 +	30 -49
Gender	Male	No significant impact	No significant impact
Employment	full time employment	others	others
Income	under 10 k	trend is not clear	trend is not clear

Significantly negative at 95% confidence interval
Negative but not significant
Positive but not significant
Significantly positive at 95% confidence interval

Most of the factors are quite significant in the separate model analysis, such as bus frequency, journey purposes, time of the day etc. The sign of model coefficient estimates were sensible and the order of the magnitude followed a very sensible trend.

For example, for the time of day factor, we found that compared to AM peak, the coefficients for other time periods were positive and significant, indicating that compared to the AM peak time, bus users who travelled on the other time periods valued waiting time less. The same pattern was found for in-vehicle time. Another example is weather condition, compared to dry conditions (sunny or cloudy), rainy conditions were found to be negative, both for the expected waiting time and in-vehicle time, indicating participants have strong aversion for waiting and travelling in rainy weather. This provides a reassurance that participants answered the choice experiment in a rational way.

We could not identify significant impacts as a result of ticket type, travel group size, gender and income.

Then a series of factors were selected to develop a more complicated combined model. The procedure of selecting the factors to the preferred model is summarised as below.

The selection was based on the experience from previous studies and the model run outputs from this study. For instance, journey length was found to have impact on the in-vehicle time coefficient from previous evidence and was also found to be significant in the current study; therefore it was retained in the combined model.

In the selection, factors were selected to avoid confounding effects between different variables which might be correlated. For instance, we found that journey purpose was correlated time of travel and travel frequency (i.e. travellers for commuting purposes normally travel during the AM peak /PM peak and are quite frequent travellers compared to other purposes). After comparing the outputs and model fit from separate models, journey purpose was selected as the key explanatory variable to take forward into the combined model.

Other factors (such as weather condition) were not included on the basis that they would increase the complexity of calculation of the waiting time multipliers and would be hard to operationalise in scheme appraisal.

During the initial development of the models we did not take account of the fact that participants provided more than one observation and that the observations from the same individual are correlated (each participant provided eight choice responses). It is known that naive models that do not take account of the fact that individuals provide a number of potentially correlated responses will underestimate the standard errors of the coefficient estimates, leading to inflated levels of statistical significance. Therefore, as a final step in the estimation procedure, a 'bootstrap' re-sampling procedure[12] was applied to take account of the panel nature of the SP data. The application of the 'bootstrap' procedure ensures that the standard errors and t-ratios produced by the models are a realistic statement of the true errors of the model parameters. Table 25 presents the preferred combined model. The model coefficients reflect the results after bootstrapping to take account of repeated observations being collected from a single individual.

12 Efron & Tibshirani (1993).

It should be noted that the influence of the various factors are included in the model using incremental effects (additive terms). Therefore, the coefficients can be added to get a combined effect. For example, for participants who are aged 17 – 20 and travelled on a low frequency routes (assuming all the other factors are at the reference level), the coefficient for waiting time is -0.1284 (0.1031 + 0.0645 + (-0.296)).

Looking at the model results:

- Both time coefficients are strongly estimated with a correct sign (negative), indicating that all the other conditions being equal, participants prefer options with lower waiting and lower journey times.

- The constants on the "Not travel by bus" terms are significantly negative for each journey length group by different recruitment method. This indicates that participants are less likely to select this option compared to the options of making bus journeys.

- In terms of scale parameter, compared to the responses of those completing the online survey, the responses from those recruited at the bus stop and undertaking telephone interviews show higher level of noise (smaller scale parameter). This finding is in line with what we found about the perceived difficulty of choice making from the diagnostic questions.

- Compared to the responses from those making short and medium journeys, the responses from the long journeys group show a higher level of noise as the scale parameter for the long journey group is significantly lower than that of the reference group.

Table 25: Model results, preferred combined model

Summary statistics	
Observations	12696
Final Log Likelihood	-10213.1
D.O.F	21
$Rho^2(0)$	0.268
$Rho^2(c)$	0.107

Variables	Estimate	t-ratio
Journey time coefficients		
Expected Waiting time	-0.296	-13.0
Expected Journey Time	-0.117	-7.9
Influence of other factors on the expected waiting time		
Low bus frequency	0.064	2.5
Aged 17 - 20	0.103	3.6
using Internet to check bus arrival information	0.089	1.8
using both Mobile and Internet to check information	0.137	2.4
Influence of other factors on the in-vehicle time		
other leisure journey purposes	0.029	3.9
using Mobile to check information	-0.029	-2.0
using Internet to check bus arrival information	-0.052	-2.5
using both Mobile and Internet to check information	-0.029	-3.3
Constants - Not travel by bus options		
Not travel - short journey length telephone recruitment	-9.795	-0.3
Not travel - medium journey length telephone recruitment	-16.854	-0.1
Not travel - long journey length telephone recruitment	-14.612	-0.3
Not travel - short journey length CAPI recruitment	-4.504	-10.4
Not travel - medium journey length CAPI recruitment	-7.914	-12.6
Not travel - long journey length CAPI recruitment	-14.465	-5.5
Not travel - short journey length online recruitment	-3.871	-13.1
Not travel - medium journey length online recruitment	-7.434	-15.6
Not travel - long journey length online recruitment	-13.427	-10.6
Model structure coefficients		
scale parameter for online survey (ref.)	1.000	n/a
scale parameter for telephone interview	0.317	3.2*
scale parameter for short and med. journey length (ref)	1.000	n/a
scale parameter for long journey length	0.515	4.0*

T-ratio with regard to 1.0 (reference value)

With regard to the influence of socio-economic and journey characteristics on the value of waiting time, Table 26 presents a summary of the impact and multiplier calculated for each sub-group

Table 26 Influence of other factors on the time attributes and multipliers calculated

	Sample %	Waiting time (A)	Journey time (B)	Multiplier (A/B)
Expected Waiting time		-0.296		
Expecting Journey time			-0.117	
Journey length				
short (< 10 minutes) - reference	34%			2.53
med and long (>10 minutes)	66%		-0.0294	2.02
Journey purposes				
Commuting, Edu, PB	71%			2.53
Others	29%		0.0289	3.36
Means of checking arrival info.				
not checked / NA – ref.	61%			2.53
Mobile	32%		-0.0288	2.03
Internet	4%	0.0885	-0.0522	1.23
Mobile & Internet	2%	0.1372	-0.0288	1.09
Age				
21 - 70+ (ref.)	94%			2.53
17 - 20	6%	0.1031		1.65
Bus Frequency				
High freq. and not stated (ref.)	81%			2.53
Low	19%	0.0645		1.98

Compared to participants who made journeys with a shorter **journey length** (less than 10 minutes in this study), those who made journeys with a longer length are found to value in-vehicle time more negatively (per minute). This finding is consistent with previous meta-analysis of public transport value of in-vehicle time evidence (Wardman, 2001), which reflect the increasing discomfort of long distance journeys and perhaps higher opportunity cost of time spent travelling for longer periods at a time. This results in a lower waiting time multiplier for journeys of longer lengths. The pattern of the results is in line with the study by Wardman (2014, Table4).

Compared to participants who are commuting, or travelling for personal business and education[13] **journey purposes**, those who travelled for other leisure purposes are found to value in-vehicle journey time less negatively. This leads to a higher waiting – journey time multiplier for the “Other” purposes for the same distance band. Again, this finding is in line with the meta-analysis by Wardman (2014).

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[13] Participants who travelled for employer business purpose are removed from the data analysis. This is to have a like-for-like comparison with the DfT WebTAG waiting time – journey time multiplier where the EB is not included.

We found that **live bus information**[14] impacts both on the participants' values of expected waiting time and in-vehicle time. Compared to the participants who do not have access to live bus information and those who have access but did not check before their reference journey, those who did check their bus arrival information by mobile phone and internet were found to have differences in their valuation of waiting time and journey time. The magnitude varies by different means of checking the information.

We have also found some significant impact of **age** on the waiting time attribute. People who are aged between 17 and 20 are found to have less negative values for waiting time (per minute).

Bus frequency has been found to have an impact on the participants' value of waiting time. We found that compared to participants who travelled on the high frequency routes and those for whom bus frequency information is not available, those who travelled on the low frequency routes have less negative valuations of waiting time. It is hypothesised that this is because most of the participants who travelled on these low frequency routes are familiar with the frequency of the routes and plan their journeys accordingly (only 3% of the participants who first time travelled on this low frequency routes).

Calculating recommended waiting time multipliers

The outputs from the choice modelling have been re-weighted to reflect the sample composition of the TfL bus travel survey. The weights are applied in two dimensions: age and journey purposes as these two factors are found to have a significant influence within the choice models.

It should be noted that the age band of this study does not perfectly match the TfL bus survey for the 17 – 20 age group. We have converted the age bands and journey purposes from the London bus user survey (using the same approach that Accent used) to calculate the weights. Table 27 and Table 28 present the assumptions made in converting the London bus user survey to the target age and journey purpose in this study.

Table 27 Target age bands calculation

Age bands in London bus user survey	Total	Converted age range	n	Target age range	n	%
16-17	2119	17*	1059.5	17 - 20	3778.5	10%
18-19	1753	18 - 19	1753			
20-24	4830	20**	966			
		21-24	3864	20 +	35755	90%
25 +	31891	25+	31891			
Totals			39533.5		39533.5[15]	100%

Assumptions:

[14] In the separate model analysis, we found that countdown information had an impact on the time attributes. However this impact became not significant after the bootstrap procedure. Therefore it was removed from the final combined model.

[15] The totals of the targets for age band and purpose do not match as the age band conversion includes the employer business purposes, whilst the journey purpose summary includes bus users aged 16.

*50% of the 16 – 17 age group are assumed to be 17 years of age
** 20% of the 20-24 age group are assumed to be 20 years of age

Table 28 Target purpose categories in the London Bus survey

Age bands in London bus user survey	Total	Target purpose categories in this study	Grouping	n	% (without EB)
Travelling to/from work	21702	Commuting	Commuting, PB and Education	28766	72%
To/from school/education	3091	Education			
Personal Business	878	Personal Business			
Healthcare Appointment	1095				
Taking/collecting child	461				
Picking up/dropping off someone	243				
Other	1296				
To/from shopping	4490	Shopping	Others	11018	28%
Visiting friends/relatives	3228	Visiting friends			
Holiday/Sightseeing	648	Leisure			
Leisure	2652				
Employer Business	809	EB (not used)			
Totals	40593			39784	100%

Table 29and Table 30 presents the sample composition by age and journey purpose for the current study and TfL bus user survey, respectively.

Table 29 Age and Journey purposes composition in the current study

	Commuting, PB, Edu	Others	Total
17 - 20	5%	1%	6%
21 +	66%	28%	94%
Total	71%	29%	100%

Base: 1589

Table 30 Age and Journey purposes composition in the TfL bus user survey (remove EB and night bus journeys)

	Commuting, PB, Edu	Others	Total
17-20	7%	3%	10%
20 +	66%	25%	90%
Total	72%	28%	100%

Base: 39784

Table 31 presents the weights calculated from comparison of the TfL bus user survey and the current study.

Table 31 Weights calculated for each sub-group

	Commuting, PB, Edu	Others	Total
17 - 20	1.53	2.54	1.72
21 +	0.99	0.88	0.96
Total	1.02	0.94	1

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